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TREES

I think that I shall never see
A poem lovely as a tree.

A tree whose hungry mouth is prest
Against the earth's sweet flowing breast;

A tree that may in summer wear
A nest of robins in her hair.

Upon whose bosom snow has lain;
Who intimately lives with rain.

Poems are made by fools like me,
But only God can make a tree.

—Joyce Kilmer

CULTURE AND AGRICULTURE

No other occupation compares with modern farming in the opportunity it offers for constant mental progression, if one has the native appetite for progress. . . . . Wealth and ease of life are not the necessary conditions of culture. It cannot be bought with a price or put on like a garment. Pianos and fox trots, victrolas and super-sixes, do not bring culture into country homes. It must begin on the inside of the personal and family life and blossom in words and acts that disclose superior character. And no other type of life is more favorable to the development of worthy character than is the work on the farm. The farmer needs only the vision of reality, of seeing the invisible in the visible, to appreciate the essential sacredness of the things with which he deals. He is the chief producer of mankind's daily food, the hand that feeds the world. If the understanding and contemplation of this fact do not bring a sense of the responsibility and dignity of his service, then we have much yet to pray for. . . . . .

Culture and Agriculture are not opposing terms. We are to learn and believe that agriculture needs no importation of goods from any other realm to provide food for the care and culture of men. As the fields of the earth bring forth all manner of fruits for the sustenance of the physical life, so also does their cultivation afford stimulus and direction to the mental and moral life. For no one can be a successful husbandman who does not follow the law of Nature, which is the law of God. The "Holy Earth" is the source of thoughts that reach to the Infinite, if we listen to her teaching.

Culture is the product of thoughtfulness, the understanding of facts, the appreciation of truth. If it be said that culture involves the love of poetry, all nature is a poem. If it includes a mastery of science, the farmer must be the broadest scientist. If it calls for statesmanship, farming itself is the foundation of the state. If it demands devotion to the arts, the husbandman is the keenest craftsman of them all. And if it requires creative genius to generate culture, the master of the farm is himself a creator of value, of beauty, of influence, and of new knowledge for the world's instruction.

If the farmer of today is not living up to the cultural possibilities inherent in his calling, it is because he is deaf and blind to spiritual invitations that solicit him to the mastery of forces that have produced the miracles and the wisdom of the ages. For most of us culture must take root in vocation, it cannot be brought from afar. But he who holds the plow may yet look off and look up. His mind may be busy with the conquest of the world. There is no enmity between culture and agriculture.—F. W. Howe.

—From *Essays on Agriculture*

THE PHYTOPHTHORA DISEASE OF EGGPLANT IN THE PHILIPPINE ISLANDS[1]

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WITH TWO PLATES AND FOUR TEXT FIGURES

The *Phytophthora* disease of eggplant (*Solanum melongena* L.) first broke out in the vegetable garden of the College of Agriculture at Los Baños, Laguna, in 1918. The disease has since occurred every year and at times caused considerable damage to fruits of eggplant. From November, 1923, to August, 1924, weather and other environmental conditions were favorable for the *Phytophthora* disease. Infection was very common not only in the garden of the College of Agriculture but also in *caiñgins* (new and imperfect forest clearings) in the vicinity of the College Farm.

THE DISEASE

Distribution and importance

A disease of eggplant caused by *Phytophthora melongenæ* Sawada is reported from Japan (Tanaka, 1917). According to K. Sawada (Tanaka, 1917) the disease attacks all varieties of eggplant in Japan and in one case it caused 60 to 70 per cent of loss.

The disease is not reported from any country except Japan and the Philippine Islands.

During the season when the *Phytophthora* disease was very common, actual counts of infected fruits on the plants showed that from 25 to 75 per cent were infected in varying degrees by the disease. The survey was made in the garden of the College of Agriculture where the eggplants were planted at distances of about 0.5 by 0.75 meter. Although the disease is usually of minor importance, under favorable weather conditions and in a crowded situation the *Phytophthora* disease may cause serious infection.

Symptoms

The *Phytophthora* disease starts on any portion of the fruit. The lesions are dark colored, either circular or irregular with indistinct border and water-soaked appearance. Some infected areas are a few millimeters in diameter while others involve entire fruits. The lesions grow rapidly and cover mature fruits in three to four days. The disease infects fruits in all stages of development; that is, after the petals fall up to maturity (plate I, fig. 1 and 2), and cause them to drop off. During the wet season, white mycelium of the causal fungus is present on dead peduncles, infected fruits (plate I, fig. 2), leaf petioles, leaf blades, on debris, and on the surface of the soil. In damp chamber the superficial growth of mycelium on fruits of eggplant appears in four to five hours. The *Phytoph-*

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thora disease differs in appearance from that caused by *Colletotrichum* sp., *Glœosporium melongenæ* Sacc. and *Phyllosticta hortorum* Speg. on account of the water-soaked dark colored and delimited lesions. The *Phytophthora* lesions are neither sunken nor zonated.

CAUSAL ORGANISM

Morphology

Mycelium. In pure culture on various agars and sterilized plant tissues, an abundance of aërial and submerged mycelium is produced. The mycelium is coarse, hyaline, and granular as in other species of *Phytophthora.* Young hyphæ are cœnocytic and contain globules and granules of varying sizes. Large vacuoles and septa are often present in old hyphæ. The mycelium is either simple or branched. In pure culture, branching and formation of numerous protuberances are common in submerged mycelium. The aërial hyphæ are long, usually simple, smooth, uniform in outline and vary from 3 to 8 μ in diameter. Submerged hyphæ are irregular in outline.

Conidiophores. The conidiophores are smaller than the vegetative hyphæ. They may be either short or long, usually simple, granular, and bear a single apical conidium (plate II, fig. 1).

Conidia. The Philippine eggplant *Phytophthora* produces but few conidia and these are usually borne singly on the conidiophores (plate II, fig. 1 and 2). The conidia are ovate, granular, hyaline, with prominent papilla and sometimes one or two vacuoles. Sawada (Tanaka, 1917) states that the conidia of *Phytophthora melongenæ* are spherical, broad oval or oval. The writer's measurements of the lengths and widths of 400 conidia from pure culture on oatmeal agar from two to four weeks old are given in table 1 where they are distributed in classes made by a difference of two microns. This method is recommended by Rosenbaum (1917) in his studies of the genus *Phytophthora.*

TABLE 1

Distribution of the lengths and widths of conidia, and diameters of chlamydospores of the Philippine eggplant Phytophthora in classes made by a difference of two microns

LENGTH CLASSES IN MICRONS	CONIDIA IN 400	WIDTH CLASSES IN MICRONS	CONIDIA IN 400	DIAMETER CLASSES IN MICRONS	CHLAMYDOSPORES IN 400
———	—	15.5 to 17.49	1	———	—
———	—	17.5 to 19.49	1	17.5 to 19.49	7
———	—	19.5 to 21.49	6	19.5 to 21.49	8
21.5 to 23.49	1	21.5 to 23.49	18	21.5 to 23.49	21
23.5 to 25.49	2	23.5 to 25.49	68	23.5 to 25.49	50
25.5 to 27.49	5	25.5 to 27.49	48	25.5 to 27.49	31
27.5 to 29.49	47	27.5 to 29.49	112	27.5 to 29.49	85
29.5 to 31.49	36	29.5 to 31.49	38	29.5 to 31.49	42
31.5 to 33.49	77	31.5 to 33.49	53	31.5 to 33.49	76
33.5 to 35.49	46	33.5 to 35.49	23	33.5 to 35.49	39
35.5 to 37.49	68	35.5 to 37.49	25	35.5 to 37.49	30
37.5 to 39.49	28	37.5 to 39.49	3	37.5 to 39.49	9
39.5 to 41.49	42	39.5 to 41.49	2	39.5 to 41.49	2
41.5 to 43.49	23	41.5 to 43.49	1	———	—
43.5 to 45.49	14	43.5 to 45.49	1	———	—
45.5 to 47.49	4	———	—	———	—
47.5 to 49.49	4	———	—	———	—
49.5 to 51.49	2	———	—	———	—
51.5 to 53.49	1	———	—	———	—

It may be seen in table 1 that the lengths of 400 conidia fall in classes between 21.5 to 23.49 μ and 51.5 to 53.49 μ. The widths fall in classes between 15.5 to 17.49 μ and 43.5 to 45.49 μ. The majority of the conidia have lengths in classes between 27.5 to 29.49 μ and 43.5 to 45.49 μ and widths between classes 21.5 to 23.49 μ and 35.5 to 37.49 μ. The greatest number of the conidia have lengths in class 31.5 to 33.49 μ and widths in class 27.5 to 29.49 μ. The average size of the conidia based on 400 is 34.8×28.4 μ. Figures 1 and 2 present the measurements of the conidia in graphic form.

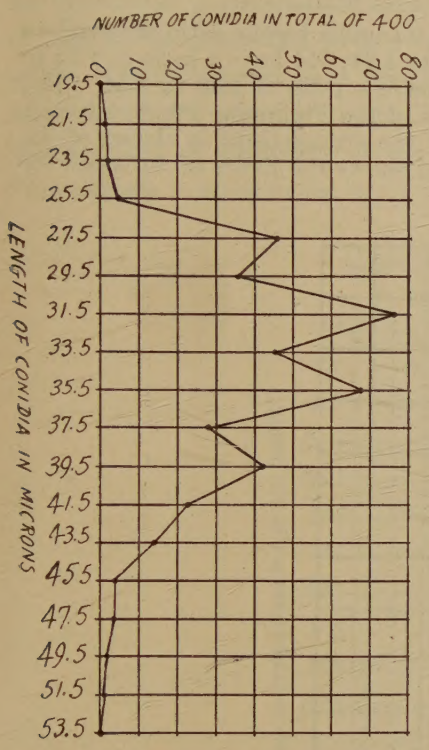

Fig. 1. Graph showing the variation in length of conidia of the Philippine eggplant *Phytophthora*.

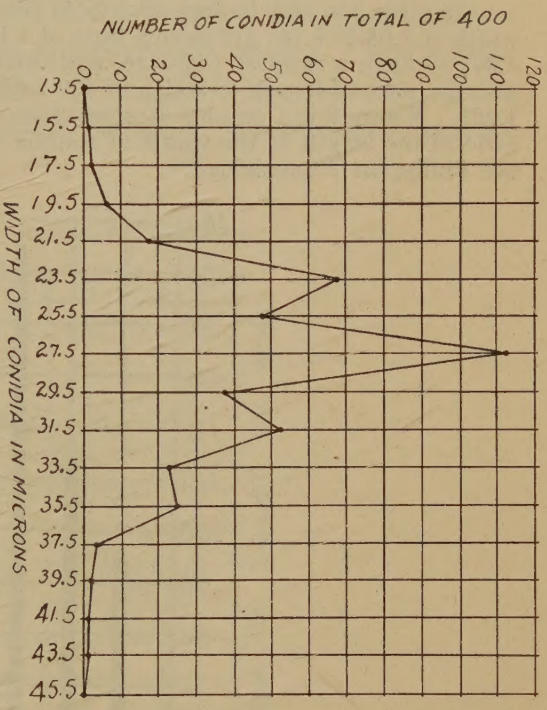

Fig. 2. Graph showing the variation in width of conidia of the Philippine eggplant *Phytophthora*.

K. Sawada (Tanaka, 1917) reports that the conidia of *Phytophthora melongenæ*[2] are 24-72×20-48 μ, with an average size of 42.4×33.9 μ. Basing calculations on the average size of the conidia, the Japanese *Phytophthora* is 7.6 μ longer and 5.5 μ wider than the Philippine eggplant fungus. Since the size of the conidia of species of *Phytophthora* is quite variable and the number of conidia measured by Sawada is not known, the difference in size of the conidia of the Philippine and Japanese fungi cannot be given much taxonomic value.

Ratios of lengths of conidia to widths. The ratios of lengths to widths of 400 conidia were determined and distributed in classes made by a difference of 0.09 μ as shown in table 2.

[2] The writer expresses appreciation of the courtesy of Dr. Takewo Hemmi of the Kyoto Imperial University, Kyoto, Japan, in sending him a transcription of the English translation of the description of *Phytophthora melongenæ* on eggplant in Japan.

TABLE 2

Ratios of lengths to widths of 400 conidia of the Philippine eggplant Phytophthora distributed in classes made by a difference of 0.09 micron

RATIO CLASSES IN MICRONS	NUMBER OF CONIDIA IN 400
1.05—1.14	97
1.15—1.24	113
1.25—1.34	154
1.35—1.44	33
1.45—1.54	3

In table 2 it may be seen that 97 of the 400 conidia have a ratio of length to width of 1.05 to 1.14; 113 have a ratio of 1.15 to 1.24; 154 have a ratio of 1.25 to 1.34; 33 have a ratio of 1.35-1.44, and three have a ratio of 1.45 to 1.54. The average ratio of length to width of 400 conidia of the Philippine *Phytophthora* is 1.225. Figure 3 is a graphic representation of the arrangement in classes of the ratio of the length to the width of conidia and shows the limits of variation for the Philippine *Phytophthora*.

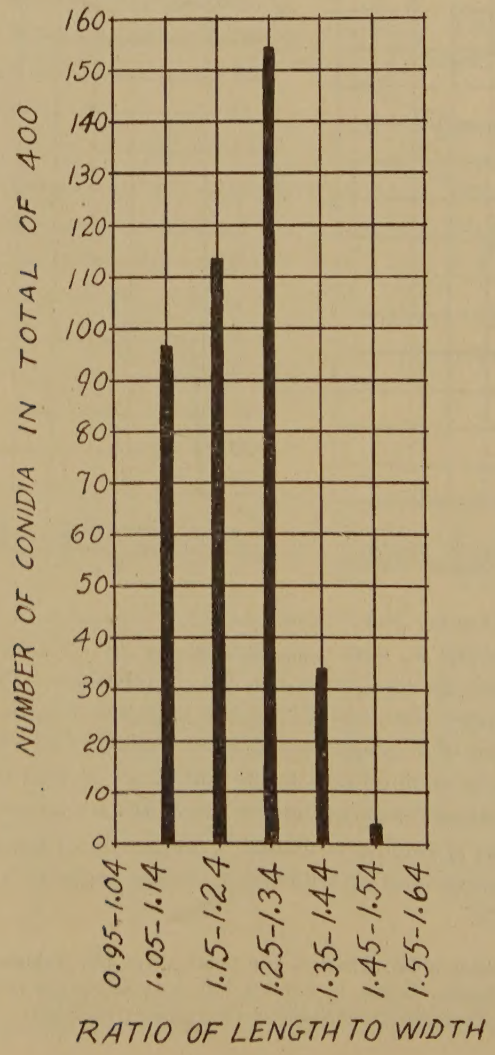

Fig. 3. Arrangement in classes of the ratios of the length to the width of conidia of the Philippine eggplan *Phytophthora*, showing the limits of variation.

The ratio of length to width of the conidia of *P. melongenæ* based on the average size given by Sawada is 1.221. According to the ratios of length to width of conidia the Philippine fungus is very much like *P. melongenæ*.

Chylamydospores. The chlamydospores are spherical, terminal or intercalary, hyaline to slightly yellowish, finely granular and thin walled (plate II, fig. 3). Measurements of 400 chlamydospores of two- to four-week-old oatmeal agar cultures were distributed in classes made by a difference of two microns (table 1). In table 1 it may be seen that the diameters of the chlamydospores are distributed in classes from 17.5 to 19.49 μ and 39.5 to 41.49 μ. A majority of them fall in classes 21.5 to 23.49 μ and 35.5 to 37.49 μ. The greatest number of the chlamydospores have diameters in class 27.5 to 29.49 μ. The average diameter of 400 chlamydospores is 29.1 μ. A graphic representation of the measurement of diameters of the chlamydospores of the Philippine eggplant *Phytophthora* is given in fig. 4.

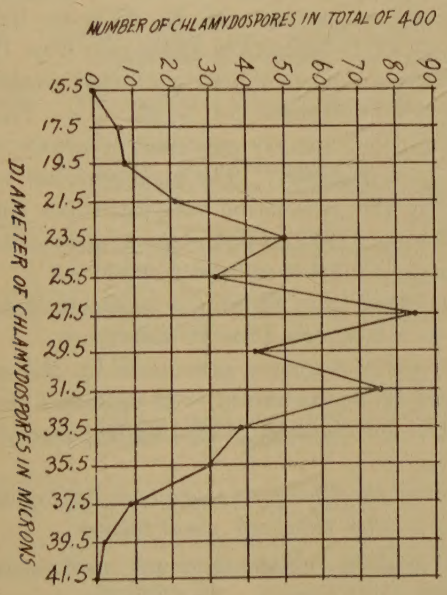

Fig. 4. Graph showing the variation in the diameter of chlamydospores of the Philippine eggplant *Phytophthora*.

Sawada describes the chlamydospores of *Phytophthora melongenæ* as yellowish-brown, spherical, and 25 to 42 μ in diameter. It may be seen that the chlamydospores of the Philippine eggplant *Phytophthora* are smaller than those of *P. melongenæ*. Inasmuch as the number of chlamydospores on which Sawada's figures for diameters are based is not known, a fair comparison cannot be made.

Oöspores. Oöspores were first found in 16-day old oatmeal-agar cultures. They are not frequently produced. Oöspores were produced in hanging-drop cultures of potato-dextrose agar in 48 hours and on smears of oatmeal agar on

slides kept in small moist chambers, and on Lima-bean agar[3], and eggplant-agar slants[4]. The *Phytophthora melongenæ* in Japan is reported as producing oögonia in bean agar.

The oöspores of the Philippine eggplant *Phytophthora* are spherical, bright yellowish brown, and thick walled. The outer surface of the wall is uneven due to thickening. On oatmeal agar the oospores vary from 16 to 24 μ in diameter and on Lima-bean agar they are slightly smaller. Sawada's figure for the diameters of oospores on bean agar is 17 to 21 μ. The oospores are borne in oogonia. The oogonia produced on oatmeal agar are 24 to 32 μ in diameter. Sawada's figures for the size of the oogonia of the Japanese fungus is 18-23×20-24 μ.

Oogonia and antheridia are produced on branches of different hyphæ as reported by Sawada. An examination of the formation of antheridia and oogonia in Van Tieghem cell cultures shows that the antheridia envelop the oogonial stalk (plate II, fig. 4).

Germination of conidia and chlamydospores

Conidia. Conidia of the Philippine eggplant *Phytophthora* germinate either by the production of germ tubes (plate II, fig. 5) or by the production of zoospores (plate II, fig. 6a and b.). Mounts in water over Van Tieghem cells of conidia taken from pure culture on oatmeal agar produced zoospores in three to five hours at our laboratory temperatures (24° to 30° C.). The zoospores are irregular in shape when in motion, but are spherical or nearly so when at rest; and measure 5.40 to 10.08 μ in diameter. The zoospores left in Van Tieghem cells over-night germinated by the production of germ tubes (plate II, fig. 7.). According to Sawada (Tanaka, 1917) *Phytophthora melongenæ* produces as many as 40 zoospores which are ovoid or ellipsoid 10-11×8 μ. Not more than 12 zoospores have been observed from Philippine materials so far. The direct germination of the conidia is not reported for *P. melongenæ*.

Chlamydospores. Chlamydospores germinate by the production of one to several germ tubes (plate II, fig. 8a and b.) In Sawada's description no mention is made of the method of germination of chlamydospores of *P. melongenæ*.

The production of spores of the Philippine eggplant Phytophthora on various agars and sterilized plant tissues

The production of conidia, chlamydospores, and oospores was studied on various agars and cooked plant tissues. The cultures were grown in the laboratory at a temperature of 24° to 30° C. The cultures were examined at two different intervals for types of spores produced. The results are given in table 3.

[3] The Lima-bean agar used in this work was prepared by taking 200 grams of green pods of Lima bean (*Phaseolus lunatus* L.). The pods, including seeds, were cut a centimeter long and boiled in 500 cc. of tap water, allowing to boil for half an hour. Fifteen grams of agar shreds were dissolved in 500 cc. of tap water. The liquid from the boiled bean pods was decanted and made up to 500 cc. by addition of tap water and added to the 500 cc. of dissolved agar. The liquid was boiled for half an hour with constant stirring, adding 20 grams of glucose to the boiling mixture. When the sugar was in solution the mixture was filtered through cotton while hot and the volume made up to 1,000 cc. The medium was tubed and sterilized for 30 minutes at 8- to 10-pounds' pressure.

[4] The eggplant agar was prepared by cutting 200 grams of fruits into slices and cooking them in 1,000 cc. of tap water for 30 minutes. The liquid was decanted and 15 grams of agar shreds added. When the agar was dissolved in the boiling eggplant decoction, 20 grams of dextrose were added. The mixture was filtered, tubed, and autoclaved for 30 minutes at 15-pounds' pressure.

TABLE 3

The production of conidia, chlamydospores, and oöspores of the Philippine eggplant Phytophthora on various agars and sterilized plant tissue

MEDIA AND COOKED PLANT TISSUES	KINDS OF SPORES PRODUCED	
	at 22 days of age	at 23 days of age
1. Pineapple fruit cylinders	No conidia, chlamydospores, or oöspores	No conidia, chlamydospores or oöspores
2. Eggplant fruit cylinders	Abundant conidia and chlamydospores but no oöspores	Abundant conidia and chlamydospores but no oöspores
3. Eggplant agar	Abundant conidia, chlamydospores, and oögonia and antheridia in process of fertilization	Abundant conidia, chlamydospores and oöspores
4. Ripe pineapple fruit agar prepared the same as potato dextrose agar except that 300 grams of finely cut peeled pineapple fruit were substituted for the potato	Conidia and chlamydospores were present but no oögonia and antheridia produced	Conidia and chlamydospores were present but no oöspores
5. Potato-dextrose agar	Few conidia and chlamydospores but no oöspores	Few conidia and chlamydospores but no oöspores
6. Coconut meat cylinders	No conidia, chlamydospores, or oöspores	No conidia, chlamydospores or other spore forms
7. Lima-bean agar	Conidia and chlamydospores without oöspores were formed in 14 days	In 23 days old cultures conidia, chlamydospores, and oöspores were present
8. Potato cylinders	No conidia, chlamydospores or oöspores were produced	Few conidia and chlamydospores
9. One and one-half per cent water agar	Conidia and chlamydospores which were empty were present	Conidia and chlamydospores few and empty
10. Oatmeal agar	Fairly numerous conidia and chlamydospores but no oöspores were produced	Conidia and chlamydospores more than at 22 days old. Oöspores present in few of the test tubes
11. Thaxter's hard agar	Numerous conidia and chlamydospores	Numerous conidia and chlamydospores
12. Sherbakoff's corn meal agar (1917)	Very few conidia and chlamydospores	Few conidia and chlamydospores
13. Five per cent prune decoction agar prepared as potato agar without glucose	No conidia; only a few chlamydospores were produced	——
14. Sterilized bean pods	Few conidia and chlamydospores were present	——

In cultural work very little growth was produced on water agar. On pineapple fruit cylinders the growth was not vigorous and the surfaces of the substrata were not covered. An abundance of aërial growth of hyphæ was produced on all agars, especially on oatmeal agar and potato-dextrose agar. On potato cylinders and coconut meat cylinders the growth was very thick, compact, cottony, and white and covered the entire cylinders. On eggplant fruit cylinders the growth was not as heavy as on potato and coconut cylinders.

No conidia, chlamydospores, or oöspores were produced on pineapple cylinders and coconut meat cylinders. Few conidia and chlamydospores were produced on potato-dextrose agar, potato cylinders, Sherbakoff's corn meal agar, or bean pods. Only few chlamydospores were produced on prune-decoction agar. An abundance of conidia and chlamydospores was produced on eggplant cylinders, eggplant agar, and Thaxter's hard agar. Oospores were produced on eggplant agar, Lima-bean agar, and oatmeal agar.

Proof of pathogenicity

Inoculation experiments were started on May 9, 1924. Two-month old potted eggplants were inoculated with bits of mycelium of 16-day old oatmeal-agar-cultures on leaf buds. Another set was inoculated in the same manner with a 42-day old culture. On leaf buds of check plants, bits of sterile oatmeal agar were placed. Both inoculated and check plants were placed in the damp chamber for 48 to 72 hours. After five days 100 per cent of the plants inoculated with the 16-day old oatmeal agar-culture were infected. Only 16.6 per cent of those inoculated with 42-day old culture of the fungus became infected. In both cases the checks remained healthy. The buds of inoculated plants turned brown and rotted. The lesions worked downwards in the stem. As a result of the infection one or more buds developed below the borders of the lesion, but the plants did not develop to normal size.

On May 20, 1924, potted plants two and one-half months old were inoculated on the buds with 16-day old oatmeal-agar-cultures of the fungus. The inoculated and the check plants were placed in the damp chamber for 72 hours. On the fourth day infection on 50 per cent of the plants took place, but the checks remained free from infection.

In all inoculations the fungus was recovered in re-isolation.

Under field conditions infection of leaf buds was not observed. During the wet season, lower older leaves in contact with the soil or infected fruits were infected in the field.

On July 8, 1924, fruits of varying ages in the field were inoculated with bits of mycelium from 7-day old oatmeal agar cultures. The fungus mycelium was placed on the uninjured fruits without cover. On checks, bits of sterile oatmeal agar were used. On account of the sunny days which followed, the inoculum dried out and only one of the fruits became infected. The checks remained healthy.

Fruits five to ten centimeters long, inoculated by placing bits of mycelium under the calyx, became infected while the checks remained healthy. All fruits stabbed with the sterile flattened end of the platinum needle and mycelium of 7-day old oatmeal agar-cultures inserted into the wounds became infected. The checks which were stabbed also but with sterile oatmeal agar inserted into the wounds were free from infection. In these three inoculation experiments the causal *Phytophthora* was recovered in re-isolation.

On July 19, 1924, fruits of varying ages were inoculated by inserting mycelium of 18-day old oatmeal-agar culture into wounds made with the sterile platinum needle. Two days later, 100 per cent of the inoculated fruits were beginning to rot and cottony white growth of hyphæ was abundant on the lesions. The checks remained healthy.

Young fruits in which bits of mycelium were inserted under the calyx a few days after the petals fell became infected in two days. The checks remained healthy.

On July 21, 1924, rotting infected fruits were placed two to five centimeters below healthy fruits of eggplants. This experiment was to find out if the fungus on dead infected eggplants, as commonly noted in the field, is capable of causing infection. Fruits under which rotting normal fruits were placed were run as checks. After four days, fruits above the rotting infected eggplants were all infected while the checks remained healthy.

The results of inoculations by placing bits of mycelium from 21-day-old cultures under the calyx of very young fruits and in slits in the stems were positive. The results show that the *Phytophthora* of the eggplant is parasitic on fruits from the time petals fall to maturity.

Inoculations of leaves of gabi (*Colocasia antiquorum* Schott), and coconut seedlings (*Cocos nucifera* L.), tobacco (*Nicotiana tabacum* L.), mustard (*Brassica juncea* (L). Coss.), patola (*Luffa acutangula* (L). Roxb.), roselle (*Hibiscus sabdariffa* L.), and camote (*Ipomœa, batatas* Poir) gave negative results. The fungus infects bark of pummelo (*Citrus maxima* (Burm.) Merr.), fruits of pepper (*Capsicum annuum* L.), fruits of tomato (*Lycopersicum esculentum* Mill.), leaves of lettuce (*Lactuca sativa* L.), and potato stems (*Solanum tuberosum* L.), especially if these are wounded.

Taxonomy

Considering the variability of characters of species of *Phytophthora*, the influence of climatic conditions and other environmental factors upon the growth and development of the fungus, and the fact that the number of spores measured by Sawada is not known, the differences between the Philippine eggplant *Phytophthora* and *Phytophthora melongenæ* Sawada are not of much taxonomic value. Until further data about *P. melongenæ* are available for purposes of comparison with the Philippine fungus, the writer refers the *Phytophthora* attacking eggplant in the Philippines provisionally to the species *Phytophthora melongenæ* Sawada.

Reinking (1923) reports that in addition to *Phytophthora faberi* Maubl. which causes bud rot of coconut (*Cocos nucifera* L.) and black rot of cacao (*Theobroma cacao* L.) (Reinking, 1919, 1923) there are apparently two different strains of *Phytophthora* causing the fruit rot and blight of eggplant in the Philippines. In the present work, however, the writer found *Phytophthora melongenæ* as the only form present in diseased eggplants. Reinking also reports a strain of *Phytophthora* producing blight of roselle seedlings (*Hibiscus sabdariffa* L.); a strain causing the blight of Para rubber (*Hevea brasiliensis* (HBK) Muell.—Arg.; a strain causing the rot of abaca suckers (*Musa textilis* Née); and a strain causing blight of seedlings and buds of *Citrus* spp.. The results of the work on the *Phytophthora* blight of citrus in the Philippines will appear in a later paper.

SOURCE OF INOCULUM AND INFECTION IN THE FIELD

Field observations during the rainy season, beginning July 19, 1924, showed that mycelium of *Phytophthora melongenæ* is present on rotting leaves and petioles of eggplant, debris, and on the soil under the plants. Fruits of eggplants near or in contact with the soil or rotting infected leaves, petioles, and other debris became readily infected. The superficial growth of *P. melongenæ* was abundant

on fallen infected leaves and fruits. As infected eggplant tissues disintegrate, the fungus is left in the soil where it remains on organic matter until the next season. With the soil particles the fungus spores or parts are readily spattered to the fruits and cause infection. The fungus in the soil is the source of inoculum for primary field infection.

Infection of fruits in the field takes place on the sound and uninjured fruits in 24 to 36 hours during the wet season. Wounded fruits are more readily infected.

DISSEMINATION OF THE FUNGUS IN THE FIELD

From July 19, 1924, and throughout the rainy season infection of fruits of eggplant in the field was severe on the lower or north end of the Department of Agronomy garden. It appears as though the inoculum in decaying organic matter in the soil was carried in the stream during the rain and deposited in the lower portion of the garden. From all external appearances the condition existing in the entire field was fairly uniform, as shown by the character of the crops grown on it. Nevertheless infection of fruits or the presence of mycelium on leaves and debris in the upper or south end of the garden was comparatively rare. The writer believes that the fungus is transported from one part of the field to the other in the streams of rain water which carry soil and debris. As the fungus is in the soil it may also be readily carried on garden implements and by man.

SOME OF THE CONDITIONS FAVORABLE FOR THE DEVELOPMENT OF THE DISEASE

The eggplants in the Department of Agronomy garden were planted at the distances of 0.5 meter by 0.75 meter. When the plants began to flower the leaves of plants in one row interlaced with leaves of those in other rows. The branches were bent low and the leaves were in contact with the soil. On account of the close planting, sunlight could not reach the soil between the rows. The air could not circulate freely between the plants and between the furrows. The soil was always moist and the air had a comparatively high percentage of humidity. These conditions are very suitable for the development of *Phytophthora melongenæ*, as well as of most other fungi. On account of the presence of excessive moisture, white cottony growth of fungus mycelium was always present on the soil and debris during the months of July and August, 1924.

In the latter part of August, 1924, the greater part of the lower leaves of the plants had fallen off. On account of this thinning, few of the fruits were infected.

During the months of July and August the *Phytophthora* disease was the worst trouble of the eggplant in the Department of Agronomy garden. About the end of August other eggplant diseases caused by *Glœosporium melongenæ* Sacc., *Colletotrichum* sp., and *Phyllosticta hortorum* Speg. became more prevalent than the *Phytophthora* disease. Although the *Phytophthora* disease of eggplant occurs every year the severity of the disease varies from year to year. Its occurrence and severity is tied up with environmental factors not clearly understood. On account of the inadequacy of our present equipment it is not possible for us to determine what factor or factors of the environment are conducive to epiphytotic outbreaks of the *Phytophthora* disease.

CONTROL MEASURES

The writer's observation in 1924 shows that infection of eggplant by the *Phytophthora* disease may be reduced considerably by planting farther apart so as to permit a free circulation of air and sunshine on the soil between the rows. During the course of the present work eggplants planted one by one meter apart were only slightly infected.

Experiments on spraying with 4-4-50 Bordeaux mixture every two weeks showed reduction of infection, but the use of fungicides is not practical in our present limited scale of raising eggplants.

Collecting infected fruits would prevent the accumulation of the parasite in the soil. Deep plowing of debris and soil which show growth of *Phytophthora* mycelium is advisable.

The relation of environmental factors to the occurrence and severity of the *Phytophthora* disease is not fully understood. Hence recommendation as to what weather conditions should be avoided in order to reduce field infection cannot be made.

SUMMARY

1. The *Phytophthora* disease of eggplant caused by *Phytophthora melongenæ* Sawada occurs in Japan and in the Philippine Islands. Although the disease is usually of minor economic importance it develops serious epiphytotics during certain wet seasons in eggplant fields where the plants are set closer than one meter by one meter apart.

2. The *Phytophthora* on eggplant in the Philippines differs in some respects from the fungus in Japan. Provisionally, however, the Philippine fungus is referred to the species *Phytophthora melongenæ* Sawada.

3. The fungus is a facultative saprophyte living on organic matter and debris in the soil between seasons. The fungus is carried from one part of the field to another by streams of rain water which carry soil particles and debris, by garden tools, and by man. The fungus is splashed with soil particles by rain and thus brought in contact with fruits of eggplants.

4. The occurrence and severity of the *Phytophthora* disease are influenced by environmental conditions. In certain wet seasons the disease is very common and at other times other diseases are more common than the *Phytophthora* disease. The environmental conditions which are to be avoided in planting in order to reduce field infection of the fruits are not understood.

5. Infection may be reduced by planting eggplants farther apart so as to permit the sun to shine between the rows and to have a free circulation of the air. Spraying with standard Bordeaux mixture every two weeks in large commercial plantings, general sanitary measures, and proper cultural practice would help to reduce infection.

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ILLUSTRATIONS

PLATE I

Fig. 1. Fruits of eggplant of varying ages showing early symptoms of infection of the *Phytophthora* disease at points *i*. About ¾ natural size. (Photograph by the Photographic Division, Department of Agronomy, College of Agriculture, Los Baños, P. I.)

Fig. 2. Mature eggplants infected with *Phytophthora* disease showing the white cottony growth of hyphæ of the fungus at points *m* produced in the field during the wet season. About ⅞ natural size. (Photograph by the Bureau of Science, Manila, P. I.)

PLATE II

Figs. 1 and 2. Camera lucida drawings of conidia of the *Phytophthora melongenæ* Sawada produced in hanging drops of potato-dextrose agar showing the prominent papilla. Note the conidiophore in Figure 1. × 350.

Fig. 3. Camera lucida drawings of chlamydospores produced in hanging drop of potato-dextrose agar. × 350.

Fig. 4. Camera lucida drawings of oogonia and antheridia produced on oatmeal-agar cultures. × 350.

Fig. 5. Camera lucida drawings of germination of conidia by the production of germ tubes after four hours in sterile distilled water. × 350.

Fig. 6a and b. Camera lucida drawings of conidia germinating by the production of zoospores in water hanging drops. × 350.

Fig. 7. Camera lucida drawings of zoospores germinating after over-night in the hanging drops. × 350.

Fig. 8a and b. Camera lucida drawings of chlamydospores germinating in hanging drops by the production of germ tubes. × 350.

(Figures 1, 3, 4, 6a and b, 7 and 8a and b in Plate II were drawn by Mr. E. F. Roldan of the Department of Plant Pathology under the writer's direction. Figures 2 and 5 were drawn by the writer.)

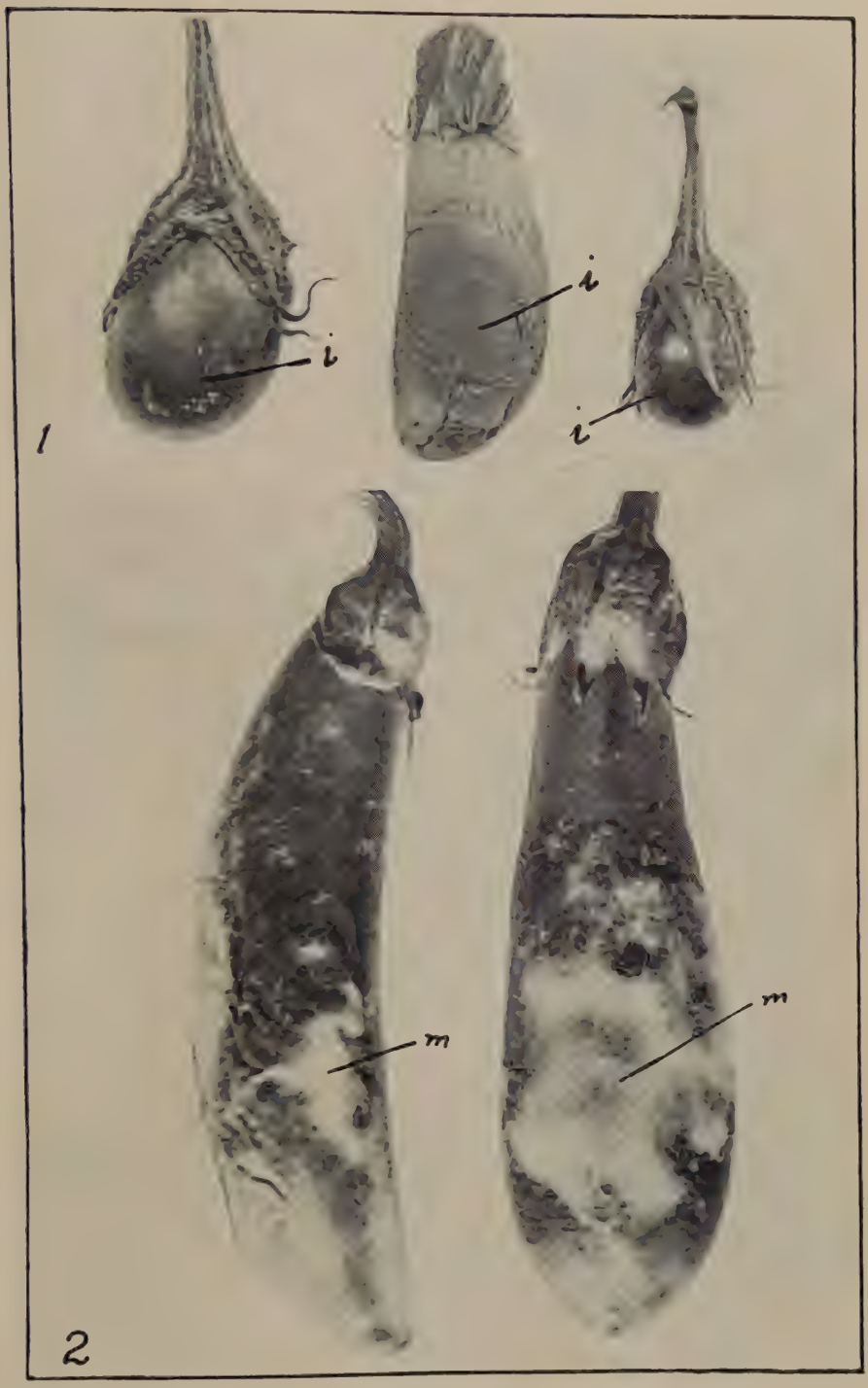

PLATE 1

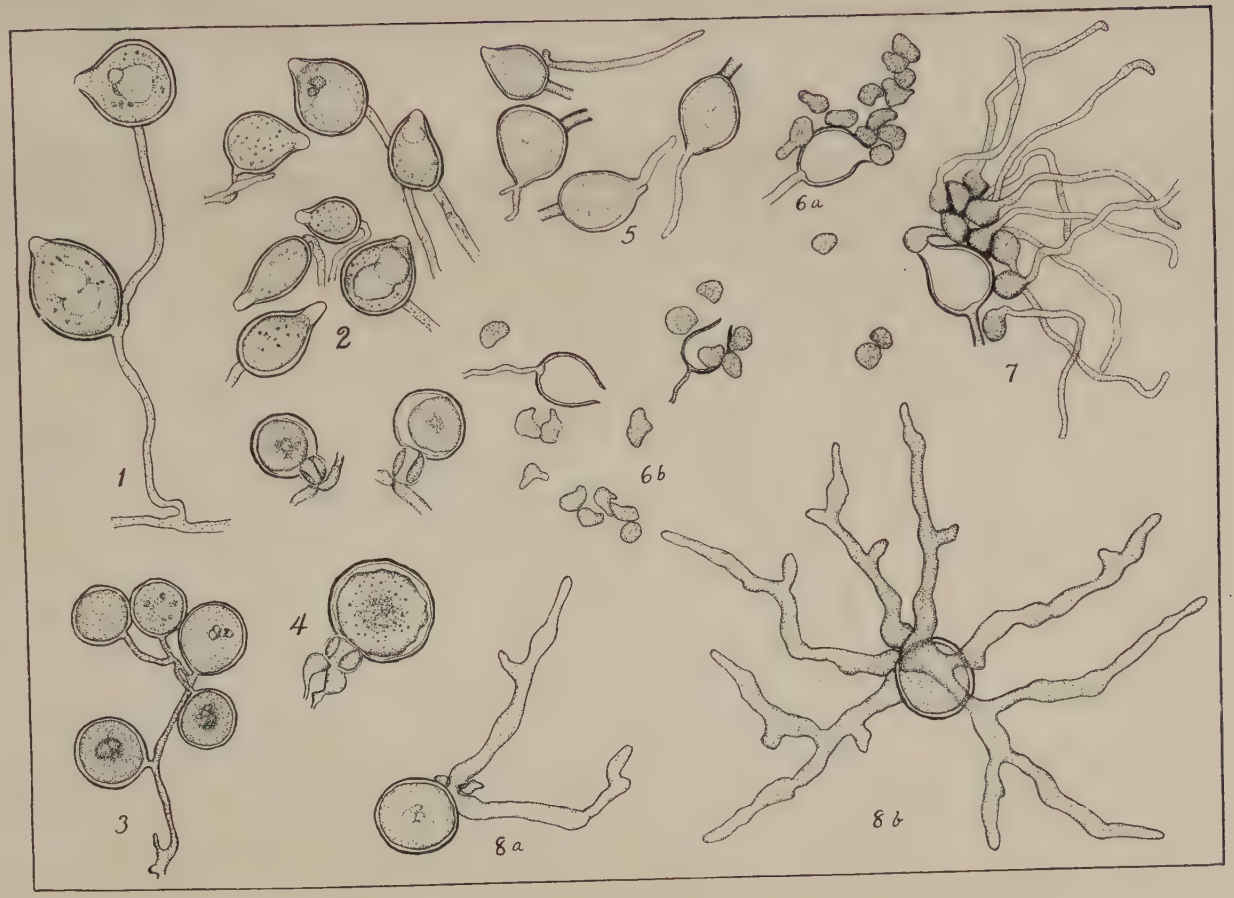

PLATE II

A STUDY OF THE ASEXUAL INHERITANCE OF STOOLING HABIT OF SUGAR CANE SEEDLINGS[1]

JUAN O. UNITE

WITH ONE PLATE

INTRODUCTION

A striking fact observed in the growing of sugar cane from the true seeds is the great variability among the seedling plants. The cane plants grown from the seeds of a variety of sugar cane constitute a heterogeneous mass of individuals exhibiting marked differences in vegetative vigor, maturity, sweetness, size, color, and other morphological characteristics. An idea of the extent of this variability may be obtained from the report of Harrison (1918) that from one arrow (flowering shoot) of a variety of sugar cane subjected under conditions where it was impossible for its arrow to be either cross fertilized by any other variety or fertilized by any other flower of its own kind, 267 different sorts were obtained.

Fortunately, "fixation," or the perpetuation of these widely different types is not a difficult problem in the case of sugar cane. For the sugar cane plant is usually propagated by tops and cuttings, and it is a general rule that plants reproduced vegetatively (asexually) come true to type. It is commonly accepted that once a new sugar cane variety is produced, its characteristics are fixed, that is, it transmits its characteristics intact to its offspring by vegetative propagation. However, Harrison points out that "soon after the cultivation of the new varieties had been extended over large areas, it became painfully evident to the majority of planters that their characteristics are not fixed, and that in many instances, characteristics which in the earlier years promised to make a variety of sugar cane of high value both in field and factory, were the first to fail. This tendency towards senile degeneration renders it necessary to raise new varieties year after year, in the hope of having fairly good varieties available to replace others which may gradually fail". It may be questioned as to whether Harrison is correct in denying fixation of characters in this case, for this denial is tantamount to denying the fact that a plant transmits its characters to its vegetative offspring. The degeneration commonly observed with sugar cane varieties may well be due to unfavorable mutations, exhaustion of soil fertility, and gradual mastery of various enemies over the variety.

In connection with asexual inheritance in sugar cane, however, there is one important point which has been generally overlooked, and that is, whether the characteristics of first sexual generation seedlings are asexually heritable to the same extent as the characters of plants asexually grown from the original first generation seedlings. An illustration should explain this point. Let it be supposed that we have two sugar cane seedlings in their first sexual generation. One

[1] Thesis presented, 1925, for the degree of Master of Science in Agronomy from the University of the Philippines, No. 207; Experiment Station contribution No. 319.

has 20 stalks and the other 5 stalks at the age of 10 months. The question may be asked: Is this tillering characteristic transmissible to their respective vegetative offspring? It will be noted that this is not the same as asking if a sugar cane plant transmits its characteristics vegetatively. This latter question is already answered. A type is generally perpetuated by vegetative propagation.

A test of the first question is of practical value in cane breeding. A proper answer to this question should also answer a second, that is, whether the number of stalks of first sexual generation seedlings may be used as a guide in selection for stooling.

At this point it may be well to define a number of terms used in this paper. By *sugar cane seedling* is meant the sugar cane plant, whether young or mature, grown from the true seed. The term *asexual inheritance* is taken to mean the inheritance of characters by offspring produced asexually as contrasted with those produced through the seed. Asexual reproduction may consist in the natural production of stalks by the parent point in plant canes and ratoon canes and in the artificial planting of points, cutting of stalks or portions of the stumps of the parent plant or hill.

The only literature the writer found on the subject of sugar cane heredity through asexual propagation, was an abstract made by Doctor Mendiola of a Dutch article by R. A. Quintus (1914) about sugar cane variability, correlation, and heredity through sexual and vegetative propagation.

In this abstract mention is made of the following points:

(1) Asexual offspring of individual varieties exhibit variability.

(2) Selection among offspring which constitute a clon was ineffective. Diameter of the stalk, stooling, and saccharose content were the characters involved in the selection.

(3) These results merely confirm the generally recognized fact that vegetative propagation of plants tends to perpetuate the characters of the parents.

(4) Points from mother stalks were found to be just as good as those from daughter stalks.

The following table is Doctor Mendiola's translation of table No. 22 of the original article. It gives the summary of the inheritance found between seedlings and their first generation vegetative offspring.

TABLE 22

Summary of the correlations of four characters of natural seedlings of the s.f. Sempalwadak and their first vegetative generation.

		A	STANDARD DEVIATION	C	COEFFICIENT OF CORRELATION
Weight per meter.....	1911	596.2 G	90.5	15.15	
	1912	629.4 G	106.0	16.90	+0.598±0.07
Stooling.....	1911	17.0	4.12	24.2	
	1912	11.0	1.925	17.5	+0.497±0.084
Length.....	1911	223.25 c.M.	20.42	9.15	
	1912	242.37 c.M.	24.40	10.03	+0.473±0.087
Cellulose %.....	1911	11.44 %	1.490	13.0	
	1912	9.54 %	1.20	12.6	+0.486±0.085
Yield.....	1911	13.94	1.277	9.2	
	1912	13.66	1.947	13.3	+0.475±0.078

It is to be observed from the coefficients of correlation given in the foregoing table that Quintus found inheritance not only of stooling but also of other characters of natural seedlings by their first vegetative offspring.

Object of the present work

The object of this study was two-fold: (*a*) To find if the stooling habit at the seedling stage is maintained up to maturity of sugar cane seedlings; and (*b*) To decide if there is always inheritance with respect to the degree of stooling of mature seedlings using second generation sexual seedlings as parent plants. In connection with the first object it should be mentioned that sugar cane seedlings, before they are ready to be set in the plot or at the time they have a good start after transplanting in the plot, exhibit very noticeable differences in their ability to produce shoots. Some produce one shoot only, while others produce three or more. If in all cases a young seedling that has three or more shoots will produce a stool that has a greater number of good and strong stalks at maturity than one that came from a one-shoot seedling, then the number of shoots would constitute an index of the ability of a young sugar cane seedling to produce good stalks.

Time and place of the present work

This investigation was begun in April, 1923, and closed in December, 1924. The experiments were conducted in the Nursery and Multiplication Field of the Division of Plant Breeding and on the Experiment Station Farm of the College of Agriculture.

MATERIALS AND METHODS

Cane seedlings used

The first batch of cane seedlings used in this work was composed of 754 mature seedlings of variety C. A. 12797. The second batch consisted of 65 seedlings of H-20; 14 of H-69; 17 of H-227; 26 of H-309; 18 of Java-247 (Bouricious 247); 36 of Hambledon-426; 79 of Mauritius Malagache; 37 of P. B. 68; and 175 of C. A. 12681. The third batch was made up of 185 seedlings, also of C. A. 12797. In this connection it should be mentioned that only a few seedlings of each of varieties H-69, H-227, H-309, Java-247, Hambledon-426, and P. B. 68 were included in this report because of the very low percentage of germination of the seeds sown.

It may be of interest to note that the seedlings of varieties H-20, H-69, H-227, H-309, Java-247, Hambledon-426, and Mauritius Malagache were in their first generation sexual stage, while those of C. A. 12797, C. A. 12681, and P. B. 68 were in their second sexual generation. All of these seedlings were natural seedlings, that is, they were grown from arrows produced in the open.

The first group of seedlings was raised by the Division of Plant Breeding from seeds sown in the cane arrowing season of 1921, and the seedlings were mature at the time the writer started this investigation. The seedlings of the second group were produced from seeds sown by the 1922-23 Agronomy 8 class in the cane arrowing season of 1922 and were just ready to be transplanted when the work began. The third group of seedlings came from seeds sown by the writer, himself, in April, 1923.

Collecting data

Data were collected when the seedling canes were in the young stage and also in the mature. The seedlings of each variety were properly labeled and numbered to prevent confusion in recording subsequent observations. The total number of shoots produced by the young seedlings was counted before transplanting in the case of some seedlings, and after transplanting, when normal growth development was observed in the case of other seedlings. In the case of mature seedlings the counting of the total number of stalks was performed prior to their being cut for vegetative propagation. The average height of stalks of each stool was measured at the time of the counting. In the determination of the total number of stalks of each stool all shoots, whether living or dead, were included.

After the total number-of-stalk and average height-of-stalk data were obtained, the mature seedling canes of each variety were classified into types with respect to total number of stalks and number of millable stalks. From the stools of the same type, two or more stalks were cut and cuttings of one-eye-each were prepared *en masse*

Cultures involved

In their sexual stage all seedling canes were grown in nursery plots about 21 square meters in size. The seedlings were planted in the plot in rows 70 cm. apart and 50 cm. apart in the row. The vegetative planting tests were conducted under field conditions in the Sugar cane Multiplication Field of the Division of Plant Breeding and on the Experiment Station Farm of the Philippine College of Agriculture. The cuttings were set about half meter apart in the row and the rows were about one meter apart. The plants were cultivated as often as necessary.

At this point it should be stated that the portion of the Sugar cane Multiplication Field used in the vegetative planting test of the seedling canes of variety C. A. 12681 is not well adapted to the best cane culture.

EXPERIMENTS AND RESULTS

The stooling habit of young first and second generation seedling canes

The seedlings were about four months old, dating from the time of germination, when the study of their relative "shooting" power was made. The results are given in table 1. This table shows the variation in total number of shoots produced by young seedlings of the same age and of the same parentage.

The stooling habit of mature first and second generation sexual seedling canes

The 754 mature seedlings of C. A. 12797 were about 16 months old at the time the total number of stalks and number of millable stalks were determined. Table 2 shows the frequency distribution of the seedlings with respect to total number of stalks and millable stalks. The seedlings of H-20, H-69, H-227, H-309, Hambledon-426, Java-247, Mauritius Malagache, P. B. 68, C. A. 12681, and C. A. 12797 (third group of seedlings) were about ten months old when the number-of-stalk and average-height-of-stalk data were secured.

The stooling habit of first generation vegetative offspring of mature seedlings

In the asexual, or vegetative cultural tests for the stooling habit of first generation vegetative offspring of the mature seedling canes, the usual method

of planting points was not followed. Instead of using points with three or more eyes each for propagating material, cuttings of one eye each were prepared. The cuttings of the same type were planted together, and the different types were arranged in the rows at the time of planting in such a way that plants of a high total number-of-stalk type grew side by side with those with a low total number-of-stalk type.

The total number of stalks and of millable stalks of the first generation asexual offspring of the mature seedlings of C. A. 12797 (first group of seedlings) was determined when the plant canes were about nine months old. The results are shown in tables 3 and 4. Counting of the total number of stalks of the first generation asexual offspring of the mature seedlings of C. A. 12681 was performed at the time the plant canes were about seven months old. Table 5 gives the results.

Tables 3, 4, and 5 are in the form of correlation tables and give the coefficient of heredity (r) found between the mature sexual seedling parents and their first generation vegetative offspring.

The writer wanted, also, to study the stooling habit of second generation asexual offspring, and for this purpose one-eye cuttings prepared from different types of first generation vegetative offspring were planted in the latter part of March, 1924. Unfortunately, a very pronounced prolonged drought occurred at this time so a very low percentage of germination resulted. Of the cuttings that germinated, only 67 stools reached maturity and most of the types under which these plants fell had only two or three stools. For this reason the writer thought it unwise to include the results of the second generation vegetative test in this report.

The stooling habit of first generation ratoon canes of first generation asexual offspring

After the final observation on the first generation asexual offspring of C. A. 12797 seedlings was made, the stalks were cut and burned when dry. The stubs were cultivated and allowed to produce shoots, or ratoon for the purpose of studying the stooling of first generation asexual offspring in their ratoon stage. The results are given in table 6. This table is also a form of correlation table and gives the coefficient of heredity found.

DISCUSSION OF RESULTS

The stooling habit of young first and second generation sexual seedlings

In table 1 it may be seen that young seedlings of each of the varieties studied exhibited quite a wide range of variability in number of shoots produced. The seedlings of Hambledon-426 showed the least range of variation while those of Mauritius Malagache gave the widest range. H-20 and C. A. 12797 seedlings had about the same range, while H-309, C. A. 12681, Java-247 seedlings closely approached each other in range. H-227, H-69, and Hambledon-426 seedlings also had about the same range of variability.

The results point out that the young seedlings of each of the varieties used, although of the same age, manifested great variation in the total number of shoots. (Plate I.)

In studying the comparative variability shown in table 1, the fact should be borne in mind that the seeds used were not selfed and that natural crossing

might have taken place inasmuch as most of the varieties used were growing side by side and flowered at about the same time.

The stooling habit of mature first and second generation sexual seedlings

By referring to table 2 it will be noted that the C. A. 12797 mature seedlings (first group) have a range of variation, in total number of stalks, of 1 to 31, and in total number of millable stalks, of 1 to 27. The mean total number of stalks and the mean total number of millable stalks are 12.01 ± 0.14 and 7.83 ± 0.08, respectively. The standard deviations are 5.64 ± 0.10 for the total number of stalks and 3.41 ± 0.06 for the total number of millable stalks. Using the standard deviation as an expression of variability, it is found that the seedlings were more variable in total number of stalks than in total number of millable stalks.

Upon examination of the data on number of stalks and average height of stalk of ten-month old seedlings of H-20, H-69, H-227, H-309, Hambledon 426, Java 247, Mauritius Malagache, P. B. 68, C. A. 12681, and C. A. 12797, it was found that type 1s of all seedlings, with the exception of H-227 and Mauritius Malagache seedlings, had a range of variation nearly as wide or wider than types having more than one shoot. Taking the seedlings of C. A. 12681 to illustrate this, type 1s has a range of variation that includes the ranges of types 2s, 3s, 4s, 5s, 6s, and 8s. However, when the mean total number of stalks is considered the mean of type 1s, 7.02 ± 0.30, is less than the mean of 8s, 16.00 ± 1.55.

In all of the seedlings of the different varieties studied the lowest number-of-shoot type never exceeded in mean total number of stalks the greatest number-of-shoot type. Looking at the means of the different types it was seen that generally there was a gradual increase in the mean total number of stalks produced. However, when any one type was compared with a type just above it, it was observed that in general the difference, if there was any, was insignificant. The results of this study show that generally the seedlings having many shoots when young produced more stalks than the seedlings that had few shoots.

In connection with the study of the stooling habit of mature seedlings the average height of stalks was also determined. It was seen that type 1s, as in the case with total number of stalks, has a range of variation nearly as wide as, or even wider, than the ranges of types considerably above it. However, when the mean average height was taken into account, it was observed that, in six cases out of nine, type 1s never exceeded the highest type. In the case of H-69 seedlings, type 1s had a greater mean average height of stalk than type 5s. Examining the mean average heights of the different types, it was observed that in general there was a gradual increase in the mean from the lower to the higher types. However, when the means of two types close to each other were considered, the difference in most cases was insignificant. The results of this study tend to show that the average height of stalks of mature seedlings is correlated with stooling power of young seedlings, in so far as the extreme classes are concerned.

The stooling habit of first generation vegetative offspring of mature seedlings

It will be recalled that the object of this experiment was to find out to what extent the stooling habit of first and second generation mature sexual seedlings was hereditary in asexual propagation. Upon examining the data in table 3 it will be seen that the first generation vegetative offspring of second generation

sexual parent seedlings of C. A. 12797 under each type varies in total number of stalks beginning below the parent type and extending considerably above it. For instance, the forty asexual offspring of sexual parents under type 6.8 average total number of stalks are distributed from 3 to 25 number of stalks, a range of 22 number of stalks. It may also be noted from this table that not only did like parents produce unlike offspring but also like offspring resulted from unlike parents. Taking the distribution of the 35 asexual offspring having a uniform total number of stalks (15) it will be observed that these 35 asexual offspring were produced by parent seedlings varying in average total number of stalks from 6.8 to 28.8.

Because of the extreme variability exhibited by asexual offspring of like sexual parent seedlings the degree of asexual inheritance could not be determined by simply considering the individual offspring separately and comparing them with the parental type. To be able to tell whether or not there was inheritance, the offspring were considered as a whole and the coefficient of heredity which is the measure of the degree of resemblance between parents and offspring with respect to the same character,—in this case total number of stalks—, was determined. As has been remarked elsewhere the method employed in the determination of the coefficient of heredity is the same as that used in determining the coefficient of correlation.

Table 3 shows that the coefficient of heredity found between the C. A. 12797 seedlings and their first generation vegetative offspring is $+0.234 \pm 0.030$. Bearing in mind that if the coefficient of heredity is less than 0.3, in cases where the probable error is relatively small, inheritance cannot be considered at all marked, the coefficient of heredity found shows that there was no asexual inheritance in total number of stalks.

Inheritance in total number of millable stalks with the C. A. 12797 first generation asexual offspring was also studied. By referring to table 4 it will be noted that the results are in line with those observed in table 3. The coefficient of heredity found is $+0.227 \pm 0.0306$. Again interpreting inheritance in the light of the coefficient of heredity with its probable error, there was no asexual inheritance in total number of millable stalks.

The results of the test with the first generation asexual offspring of the first generation sexual seedlings of variety C. A. 12681 confirmed the results obtained from the test with the C. A. 12797 seedlings. As is shown in table 5, the coefficient of heredity is $+0.194 \pm 0.333$.

The striking feature brought out in this study is, that contrary to the findings of Quintus (1914), the stooling habit of first and second generation sexual seedlings was not inherited by their first generation asexual offspring. Rather, the stooling habit of first and second generation sexual seedlings was not a varietal characteristic which was directly transmissible to the first generation vegetative offspring. Stooling habit in the cases mentioned is to be considered as a characteristic that was greatly affected by environmental influences.

The stooling habit of first generation ratoon offspring of first generation plant canes

As is shown by the results presented in table 6 the first generation ratoon offspring, unlike the first generation plant canes, tend to inherit the stooling characteristic of their parents. Of course, the offspring of a certain parental type

showed variability in total number of stalks, but, when the whole population of ratoon offspring is taken into consideration and the coefficient of heredity is determined, it becomes evident that there was decided inheritance. The coefficient of heredity as shown in table 6 is $+0.689 \pm 0.0174$.

From the results obtained so far it may be concluded that first generation ratoon offspring tend to inherit the stooling characteristic of their first generation plant cane parents. In this connection it may be said that the number of shoots produced depends, from the physiological standpoint, upon the size of the stump. Naturally, a plant cane stool with many stalks has a big stump and the larger the stump the more eyes there are on the underground stubs, hence the more shoots develop.

SUMMARY OF CONCLUSIONS

1. Young first and second generation sexual seedling canes of the same age and parentage showed a wide range of variation in total number of shoots.

2. In general the number of shoots of young seedlings was maintained up to maturity. Hence the number of shoots of young seedlings may be taken as an index of the stooling power of mature seedlings.

3. Referring to extreme types, the stooling power of young seedlings seemed to be correlated with average height of stalks of mature seedlings.

4. The stooling habit of first and second generation sexual seedlings was not inherited at all by their first vegetative, or asexual offspring. Hence the stooling power of mature seedlings could not be taken as a guide in selection of seedlings for subsequent vegetative propagation.

5. The stooling habit of first generation plant canes was inherited by their first generation ratoon offspring.

ACKNOWLEDGMENT

The writer acknowledges his indebtedness to Dr. Nemesio B. Mendiola of the Department of Agronomy for his valuable suggestions and advice during the progress of this study and in putting this paper into final form.

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ILLUSTRATIONS

PLATE I

Showing variability in stooling habit of young seedling canes.

Figures 1 and 2.—Seedlings of H–309.

Figures 3 and 4.—Seedlings of H–20.

Figures 5, 6, and 7.—Seedlings of H–69.

TABLE 1

Variation in total number of shoots produced by young seedlings of the same age and of the same parentage

CLASS VALUES	KIND OF SEEDLINGS									
	H-20	H-69	H-227	H-309	Java-247	Hambledon 426	Mauritius Malagache	P. B. 68	C. A. 12681	C. A. 12797
1	24	9	5	10	7	32	3	19	97	2
2	5	3	1	3	2	1	2	3	21	6
3	10	1	4	2	3	2	9	4	13	11
4	7	—	3	—	2	1	9	2	12	46
5	8	1	2	2	1		4	6	12	51
6	5		2	3	2		4	2	6	37
7	2			3	1		8	1	8	16
8	2			1			3		6	6
9	—			2			1			6
10	1						3			—
11	1						5			1
12							4			3
13							3			
14							3			
15							2			
16							1			
17							1			
18							2			
19							2			
20							2			
21							—			
22							2			
23							—			
24							—			
25							—			
26							3			
27							1			
28							—			
29							—			
30							1			
31							1			
Total.....	65	14	17	26	18	36	79	37	175	185
Mean.....	3.28 ± 0.20	1.64 ± 0.20	3.12 ± 0.28	3.73 ± 0.38	2.89 ± 0.31	1.22 ± 0.08%	10.17 ± 0.57%	2.54 ± 0.21%	2.43 ± 0.11%	5.24 ± 0.09%
Standard deviation..	2.42 ± 0.14	1.11 ± 0.14	1.71 ± 0.20	2.89 ± 0.27	1.97 ± 0.22	0.67 ± 0.05	7.46 ± 0.57	1.88 ± 0.15	2.06 ± 0.02	1.81 ± 0.06
Coefficient of variability.	73.78 ± 6.29%	67.68 ± 11.81%	54.81 ± 8.99%	77.48 ± 10.70%	68.17 ± 10.65%	54.92 ± 5.49%	74.34 ± 8.08%	74.02 ± 8.35%	84.77 ± 4.77%	34.54 ± 1.35%

TABLE 2

Frequency distribution of the total number of stalks and of millable stalks of mature C. A. 12797 seedlings

V	FREQUENCIES OF CLASS VALUES																																TOTAL	MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIABILITY
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34				
Total number of stalks	1	4	17	28	41	38	41	47	55	63	48	51	47	46	43	43	23	24	18	19	14	10	8	3	4	3	2	3	4	2	0	3	—	1	754	12.01±0.14	5.64±0.10	46.96±0.98
Total number of millable stalks	5	5	34	67	90	93	102	98	65	44	39	36	28	17	9	8	4	5	1	3	-	—	—	—	—	—	1								754	7.83±0.08	3.41±0.06	43.55±0.89

TABLE 3

Correlation table showing the coefficient of heredity (r) between the C. A. 12797 seedlings and their first generation asexual offspring in total number of stalks

Average total number of stalks of second generation sexual parents	TOTAL NUMBER OF STALKS OF FIRST GENERATION ASEXUAL OFFSPRING																															f	MEANS OF FIRST GENERATION ASEXUAL OFFSPRING
V	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59	61		
6.8	4	3	7	5	5	5	4	5	1	0	0	1																			40	10.70±0.54
8.8	2	1	2	1	0	3	2	4	6	1	1	1	1	0	0	0	1	1													27	16.78±1.06
10.8		1	0	2	1	4	3	1	2	6	4	0	0	0	1	1															26	18.00±0.81
12.8			1	1	4	3	3	3	0	0	0	2	2	1	0	1	0	2	0	2											25	20.68±1.41
14.8	2	1	0	3	4	2	5	5	4	4	2	4	4	2	2	4	5	2	0	0	1	3									59	23.07±0.94
16.8			1	0	0	0	3	0	0	3	6	3	3	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	2		18	27.78±2.21
18.8	4	2	4	4	2	7	7	4	4	15	5	3	13	9	6	5	5	8	3	2	0	1	0	3							116	23.95±0.66
20.8	1	2	1	0	2	2	1	4	3	0	0	0	0	1	0	0	1	1	0	0	1										20	17.60±1.57
22.8																																
24.8		1	0	0	0	1	1	1	2	2	3	3	7	4	3	2	3	1	1	0	0	1	0	1	0	1					38	27.11±1.00
26.8																																
28.8		2	4	2	7	5	6	9	8	6	4	2	2	6	3	3	0	2	3	1	0	0	0	0	0	0	0	0	0	2	77	21.23±0.87
f	13	13	20	18	25	32	35	36	30	37	19	19	32	24	15	17	15	17	7	5	2	5	0	5	0	1	0	0	2	2	446	

$r = +0.234 \pm 0.0300$

TABLE 4

Correlation table showing the coefficient of heredity (r) between the C. A. 12797 seedlings and their first generation asexual offspring in total number of millable stalks

Total number of millable stalks of second generation sexual parents	TOTAL NUMBER OF MILLABLE STALKS OF FIRST GENERATION ASEXUAL OFFSPRING																																							MEANS OF FIRST GENERATION ASEXUAL OFFSPRING
V	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	f	
3		3	1	4	1	2	1	1	3	2																																	18	5.78±0.43
4		1	0	0	1	3	1	3	0	3	1	1	1	0	1																												16	8.56±0.53
5			1	0	1	1	1	3	2	1	2	2	3	3	2	2	0	1	1																								26	11.50±0.51
6	1	2	0	0	2	0	2	2	4	0	0	2	1	0	1	2	1	0	0	1	0	0	1																				25	10.56±0.67
7	1	1	0	0	3	1	3	2	1	1	2	2	0	1	0	0	0	1	0	0	1	0	2																				25	9.72±0.83
8		1	0	1	2	1	2	2	1	1	2	0	1	1	0	0	1	3	0	1	0	1	0	0	0	1	1	1	1													25	13.72±1.06
9				1	0	1	0	1	1	0	1	1	1	1	0	2	0	2	2	0	1	0	0	0	1																		16	14.31±0.84
10											1	0	1	1	4	1	2	0	1	1	1	0	0	0	0	0	0	1	0	0	1	0	0	0	1								16	18.88±1.10
11		1	0	0	0	2	0	0	1	1	1	2	1	2	0	1	0	2	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1							18	15.72±1.46
12				1	1	1	1	1	1	1	1	0	1	0	0	2	2	1	0	3	0	0	2	0	0	0	0	0	1														19	15.16±0.99
13	1	1	0	1	2	1	3	3	3	2	1	1	6	2	2	2	0	0	0	0	0	2	0	0	0	0	0	1															34	11.12±0.65
14							1	0	0	0	0	0	1	0	0	1	2	2	1	2	2	2	3	1	2	0	0	0	1														21	20.14±0.67
15	1	0	0	1	0	1	1	2	1	2	1	5	0	0	2	2	2	2	3	3	1	0	1	0	1	2	0	0	0	0	1												38	14.71±0.71
16						2	1	0	2	1	2	5	4	1	2	1	1	3	3	4	3	0	0	0	0	0	0	1	0	0	0	1											37	15.46±0.63
17	1	0	2	1	0	0	1	2	1	2	1	1	1	1	1	2	0	0	1	0	1	0	1																				20	11.15±0.88
18	1	0	2	2	2	1	3	2	4	3	2	1	1	1	1	4	0	0	0	0	0	1	0	0	0	1	1																33	10.58±0.71
19					2	1	1	2	0	0	2	2	3	1	1	1	4	0	2	3	0	0	0	0	0	0	0	1	1														27	14.52±0.78
20						2	0	0	3	1	0	1	1	0	1	0	0	1	0	0	0	1	0	0	0	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	16	17.94±1.78
f	6	10	6	11	17	23	22	26	31	21	20	26	30	15	18	23	15	18	15	18	10	7	10	1	4	5	3	5	5	0	3	2	0	0	2	0	1	0	0	0	0	0	0	1	430	

$r = +0.227 \pm 0.0306$

TABLE 5

Correlation table showing the coefficient of heredity (r) between the C. A. 12681 seedlings and their first generation asexual offspring in total number of stalks

Total number of stalks of second generation sexual parents	TOTAL NUMBER OF STALKS OF FIRST GENERATION ASEXUAL OFFSPRING																					MEANS OF FIRST GENERATION ASEXUAL OFFSPRING
	V	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	f	
	4		2	1	1	3	1															8	4.00±0.34
	5			1	2	1																4	4.00±0.24
	6		1	1	1	0	0	0	1	1												5	5.20±0.07
	7	3	0	2	2	7	3	4	2	1	0	0	0	0	0	1						25	5.52±0.39
	8	9	2	4	8	8	7															38	3.66±0.11
	9	1	0	2	6	0	2	2	0	0	1	1										15	5.20±1.43
	10	2	0	1	7	9	8	5	1	1												34	5.24±0.19
	11	1	1	1	4	7	1	2	0	0	0	0	1									18	4.94±0.36
	12	1	2	5	4	2	5	3														22	4.41±0.26
	13	2	0	2	3		4	1	2	3	2	1	1	1	2							31	7.16±0.41
	14						2	0	1	0	0	0	0	0	0	0	0	0	0	0	1	4	10.00±1.93
	15	3	0	1	1	2	1	2	1	1	0	2	3	0	3	0	0	0	1			27	7.26±0.62
	16	1	1	3	2	0	0	0	1	1	1	1										32	5.28±1.05
	17						2	1	1	0	1											5	7.40±0.45
	18	1	3	3	1	2	5	4	6	6	2	1	0	0	1							35	6.71±0.33
	19				2	2	1															5	4.80±0.23
	20	1	1	2	1	2	2	1	0	0	0	0	0	0	1							14	4.21±0.60
	21		1	0	2	0	1	0	1	2	0	0	1									8	6.75±0.74
	22			1	2	0	0	0	1													4	4.75±0.65
	23		1	0	0	1	1	1	0	0	1	0	0	0	1							6	7.33±1.05
	24		2	0	2	2	1	3	2	0	0	1	0	1	0	0	0	0	0	1		15	7.20±0.75
	25																						
	26	1	1	1	3	1	4	1	3	3	1	2	0	2	0	0	1	0	0			30	6.57±0.47
	f	35	18	34	57	61	57	39	24	19	9	9	6	4	8	1	1	0	1	1	1	385	

$r = +0.194 \pm 0.0330$

TABLE 6

Correlation table showing the coefficient of heredity (r) between the first asexual generation offspring of C. A. 12797 seedlings and their first generation ratoon offspring in total number of stalks

| Total number of stalks of first generation asexual parents | TOTAL NUMBER OF STALKS OF FIRST GENERATION RATOON OFFSPRING | | |

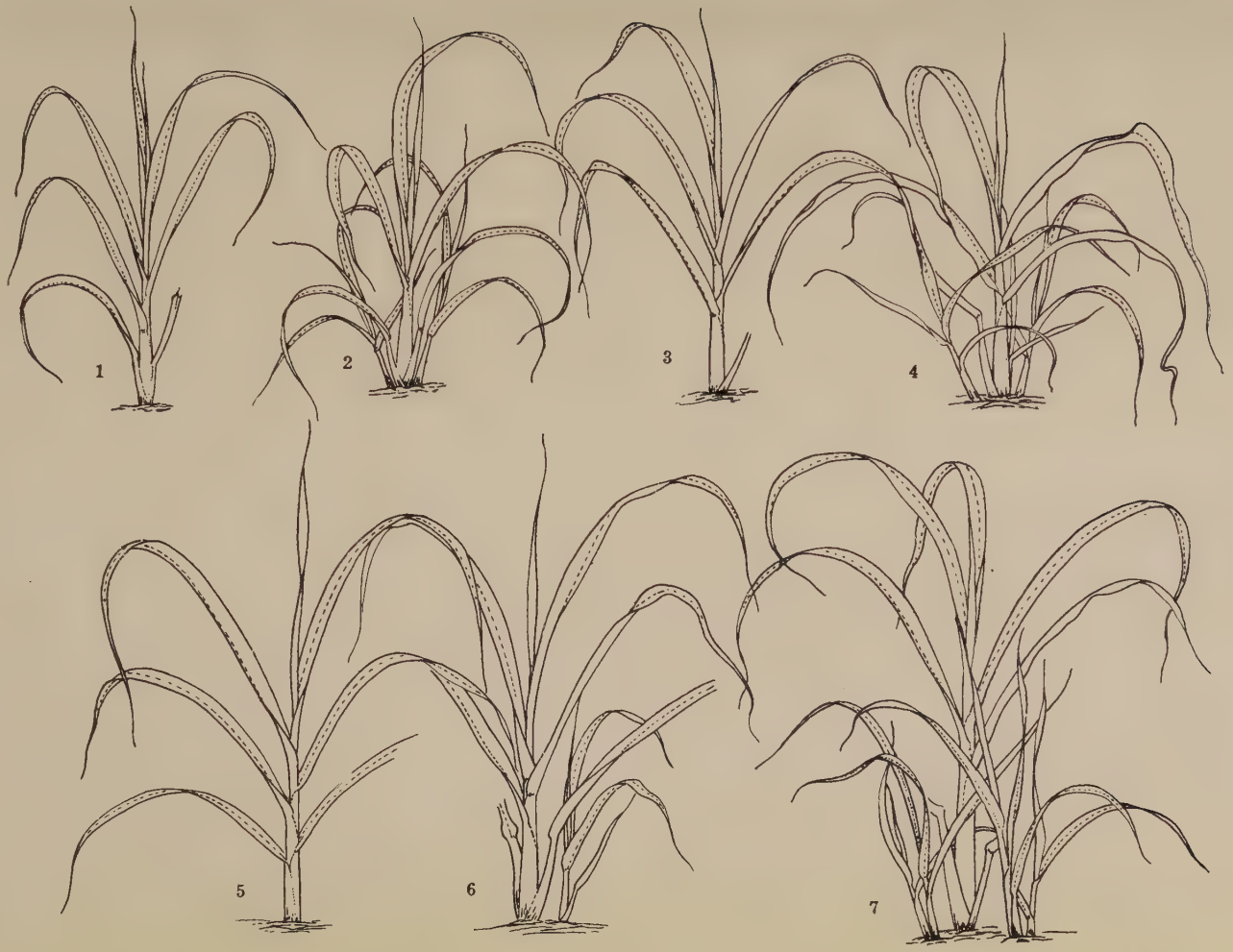

PLATE I

THE CALCIUM OXIDE CONTENT OF SOME PHILIPPINE FOODS[1]

FELIPE T. ADRIANO AND ELIGIO J. TAVANLAR

INTRODUCTION

According to Roxas (1922), the Filipino dietary may be deficient in calcium as well as vitamins and proteins. To secure data on the calcium content of Philippine food materials, we undertook the work here reported with the hope that the results might be of use to investigators in Filipino or other dietary. Obviously, all Philippine foods could not be covered in this study. So far as the authors know this is the first work on calcium content to be reported in connection with Philippine foods.

On the basis of the American standards of 0.7 gram of calcium oxide per man per day, the Filipino daily consumption is extremely deficient as shown by table 1.

TABLE 1

Calcium oxide content of American and Filipino dietaries

CALORIES IN DIET	AMERICAN[a]	FILIPINO[b]
	grams	*grams*
Over 4,000	0.79	———
4,000 – 3,500	0.94	———
3,500 – 3,000	0.99	———
3,000 – 2,500	0.92	———
2,500 – 2,000	0.36	0.101 – .132
2,000 – 1,500	0.68	0.149

[a] *Taken from* Lusk (1910).
[b] *Taken from* Roxas (1922).

MATERIALS AND METHODS

Most of the materials used were bought from the *tenderas* (local venders) in and around the College Campus. A few were from Aringay, La Union Province. Samples from the College Salesroom were analyzed from time to time.

The materials were grouped under fish, fruits, meat products, milk and other dairy products, seeds, tubers and bulbs, and vegetables.

1. Fish. Salt water and fresh water fish and shellfish were analyzed, also canned fish, as sardines.

2. Fruits. This group includes all fruits, excepting those commonly cooked as vegetables, such as peas and beans which are grouped under leguminous and non-leguminous.

3. Meat products. All animal products, other than the dairy products, were included in this group.

[1] The data used in this paper are from the thesis presented by the junior author for graduation, 1925, with the degree of Bachelor of Agriculture. Thesis No. 208; Experiment Station contribution No. 320.

4. Milk and other dairy products. Carabao's and cow's milk, butter, cheese, and oleomargarine, a very popular butter substitute, were analyzed.

5. Seeds. This group includes the cereals and leguminous seeds.

6. Tubers and bulbs. Edible tubers, rhizomes, and bulbs are given in this group.

7. Vegetables. Flowers, leaves, shoots, and fruits which are commonly cooked as vegetables are included in this group. They are subdivided into leguminous and non-leguminous.

Preparation of samples

The analyses were made of the edible portion of the sample. Whenever possible, the samples for materials, such as vegetables, seeds, and fruits were classified into three stages of maturity. Each stage was analyzed separately. Sampling was performed in such a way as to secure a representative lot of the material to be analyzed. The number of samples taken of each kind was limited by the amount of the local supply. The endeavor was made, however, to make as many analyses as possible so as to secure a better average for each material.

The different samples were carefully ground or chopped. Portions of samples were weighed for the moisture and ash determinations. The rest of the material was either oven or sun dried. The partly dried samples were then ashed in an electric muffle furnace. The ashes were stored in well stoppered vials and then placed in a dessicator to prevent the absorption of moisture.

Methods of analysis

Moisture. Duplicate samples of from two to ten grams of the finely ground materials were weighed into tared porcelain dishes. These were placed in an electric oven kept at 110° C. and dried to constant weight. The loss in weight was taken as the amount of moisture in the sample.

Ash. The residue from the moisture determination was incinerated in an electric muffle furnace at a very faint red heat. The white or gray residue free from carbon particles was weighed and taken as the weight of the ash.

Calcium. With slight modifications, the methods adopted by the Association of Official Agricultural Chemists (1920) was used. Two samples of from one to two grams of the ash of each material were weighed into 400 cc. beakers. Enough 6N hydrochloric acid solution was added to dissolve the ash, taking care that no loss by effervescence was incurred. The solutions were evaporated on an asbestos pad until nearly dry. The residue was dissolved in thirty cubic centimeters of distilled water. If all did not dissolve, the solution was filtered. The solution was treated with 6N ammonium hydroxide until a precipitate formed, and then made slightly acidic with 6N hydrochloric acid. From two to five cubic centimeters of 6N ferric chloride were added. One to three grams of sodium acetate were added to the boiling solution and it was filtered at once. The precipitate was dissolved in 6N hydrochloric acid and reprecipitated with 6N ammonium hydroxide. The combined filtrates were concentrated to about fifty cubic centimeters and then cooled. Bromine water was added until the solution was colored. Enough 6N ammonium hydroxide was added to make the solution alkaline; it was then boiled and cooled. The addition of bromine water and ammonium hydroxide was repeated. If a precipitate was obtained, the

solution was slightly acidified with acetic acid, filtered, and washed. All the filtrates and washings were concentrated to about fifty cubic centimeters and made slightly alkaline with 6N ammonium hydroxide. The solution was boiled and 6N ammonium oxalate solution was added drop by drop until present in slight excess. The solution was decanted on a filter paper. The precipitate was washed with fifteen to twenty cubic centimeters of hot water. It was dissolved in hot 6N hydrochloric acid solution and reprecipitated as above. The precipitate was washed until free from chlorides.

Instead of igniting the washed precipitate, it was at once dissolved in hot 6N sulfuric acid by pouring the acid solution into the filter paper containing the precipitate and collecting the filtrate in the beaker where the precipitation was made. The filter paper was washed free from acid and the solution was titrated hot with standard potassium permanganate solution. (The end point was indicated by the pink coloration of the solution which remains for five minutes after stirring.) From the corrected volume of the standard potassium permanganate solution used in the titration, the percentage of calcium oxide was calculated.

RESULTS AND DISCUSSION

The results are given in tables 2, 3, 4, 5, 6, 7, and 8. The percentages of the constituents reported are the averages of only concordant duplicate analyses. The percentages of calcium oxide in the dry and original samples as analyzed were computed from that in the ash.

The scientific names of the plants were taken from Merrill's Flora of Manila (1912) and those of the fishes from the labels of preserved specimens in the department of zoology of the College of Agriculture.

Of the fresh and salt water fish (table 2), *tinapa* (smoked fish) ranks first with 0.088 per cent calcium oxide; *sapsap* (salted fish), and *tuyo* (dried fish) come next with 0.084 and 0.081 per cent, respectively. Bañgos, a very common fish in the Filipino diet, has 0.036 per cent calcium oxide, and canned sardines, 0.041 per cent. The salt water fishes are, in general, richer in lime than those caught in fresh waters.

The shell fish (table 2) are richer in calcium oxide than the vertebrate fish. The clams contain, on an average, 0.098 per cent, and oysters, 0.083 per cent.

Coffee (table 3) leads all the fruits in lime content with 0.22 per cent. Coconut meat is next with 0.10 per cent. Orange, naranjita, breadfruit, apple, and watermelon are fairly rich in lime. Ates, banana, chico, cucumber, guava, lanzon, mango, papaya, and pineapple, some of the commonest fruits, are rather low in lime.

Of the meat products (table 4), locusts and hen's egg are rich in calcium oxide, with 0.200 and 0.199 per cent, respectively. Duck's egg follows with 0.127 per cent. Beef and pork, the two main sources of animal protein in the Filipino diet, are rather low in lime, containing from 0.011 to 0.013 per cent.

Of the milk products (table 5) cheese is the richest in lime content of all the foods analyzed. It supplies, on the average, 1.188 grams of lime for every 100 grams of fresh cheese. Butter is the poorest in the group. The milks are fairly rich, giving on the average 0.086 gram of lime for every 100 grams of fresh sample.

The cereals (table 6) are all low in lime. The different varieties of adlay have, on the average, 0.015 per cent; corn, 0.016 per cent; and rice, 0.014 per cent.

The leguminous seeds (table 7) are richer in lime than the cereals. Velvet and soy beans are the richest, with 0.257 per cent. Jack and Lima bean and mungo have 0.239, 0.216, and 0.185 per cent, respectively. The different varieties of peanut are the lowest, with a range of from 0.084 to 0.125 per cent.

The tubers and bulbs (table 7), like the cereals, are rather low in lime. The percentage varies from 0.012 to 0.076. Carrot, the best source in the group, contains 0.076 per cent. Onion, garlic, ginger, camote, potato, radish, all common vegetables, are rather poor in lime.

Compared with seeds, the vegetables have relatively high moisture and low ash contents. They are also rather low in calcium oxide (table 8). Of the non-leguminous vegetables, endive is the richest in lime, with 0.142 per cent, himbaba shoots and flowers have a range of from 0.084 to 0.099 per cent.

Mustard, cabbage, and lettuce, all common home garden vegetables, contain fair amounts of lime with a range of from 0.054 to 0.069 per cent. The different varieties of eggplant contain on the average 0.061 per cent.

Malungay leaves, the richest of the leguminous vegetables analyzed, have 0.150 per cent of lime. Mungo pods come next with 0.064 per cent.

SUMMARY

1. The calcium oxide content varies with the different groups of foods analyzed and even with the samples in the same group.

2. Of the fish, *tinapa* and *tuyo*, and clams and oysters are good sources of lime.

3. Of the fruits, coffee, coconut, orange, naranjita, breadfruit, and apple are rich in lime.

4. Of the meat products, locusts and eggs are high in lime.

5. Of the dairy products, cheese and milk are the richest in lime.

6. Cereals are all poor in lime, while velvet, soy, Lima and Jack beans, and mungo are relatively rich.

7. The tubers and bulbs are all poor in lime.

8. Of the vegetables, endive, malungay leaves, and himbaba-o have the largest amount of calcium oxide.

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TABLE 2

The percentages of moisture, ash, and calcium oxide in fish

NAME OF FOOD	CONDITION OF SAMPLE	NO. OF ANALYSES	MOISTURE	ASH	CALCIUM OXIDE IN:		
					Ash	Dry material	Sample as analyzed
			per cent	*per cent*	*per cent*	*per cent*	*per cent*
Fresh water							
1. Alalo (Pang.)[a]; araro (Ilk.)[b]; *Anabas testudineus*	Salted and dried	3	83.21	0.81	2.16	0.11	0.018
2. Bunog (Ilk.); bunor (Pang.); biya (Tag.)[c]; *Glossogobius girrus* Ham-Bush	Fresh	5	85.31	0.50	5.90	0.19	0.030
3. Paltat (Ilk.); pantat (Pang.); hito (Tag.); *Clarias magur* Ham-buch	Fresh	8	81.18	0.23	5.52	0.07	0.013
4. Dalag, *Ophiocepahlus striatus* Bloch	Fresh	4	83.82	0.92	5.92	0.17	0.027
Salt water							
1. Bañgos, *Chanos chanos* Forskal	Fresh	5	84.47	0.45	8.33	0.23	0.036
2. Salmon	Canned	3	64.10	2.12	0.80	0.04	0.015
3. Sapsap	Salted and dried	2	41.12	3.32	0.52	0.14	0.084
4. Sardinas	Canned	3	56.21	2.92	1.44	0.09	0.041
5. Tinapa	Salted and dried	8	40.38	10.63	8.23	1.46	0.088
6. Tuyo	Salted and dried	6	47.64	14.38	5.60	1.44	0.081
Shell fish							
1. Clams:							
Round big, cappo (Ilk.); lucan (Pang.)	Fresh	2	81.01	1.81	4.91	0.48	0.089
Round small, tulla (Tag.); bennec (Ilk.)	Fresh	15	79.82	1.72	6.21	0.62	0.106
Average							0.098
2. Oysters	Fresh	5	87.32	1.33	5.82	0.65	0.083

[a] Pang. = Pangasinan
[b] Ilk. = Ilocano
[c] Tag. = Tagalog

TABLE 3

The percentages of moisture, ash, and calcium oxide in fruits

	NAME OF FOODS	CONDITION OF SAMPLE	NO. OF ANALYSES	MOISTURE	ASH	CALCIUM OXIDE IN:		
						Ash	Dry material	Sample as analyzed
	Non-leguminous			*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
1.	Manzanitas, *Zisyphus jujuba* (L.) Lam.	Ice cold	3	82.51	0.38	5.00	0.11	0.090
2.	Ates, *Anona squamosa* L.	Fresh	4	76.21	0.78	3.00	0.10	0.023
3.	Banana: *Musa sapientum* L.							
	Boñgolan (Tag.); tumoc (Ilk.); ibeb (Pang.)	Fresh	8	79.82	0.73	3.72	0.13	0.027
	Cantong (Ilk.); latundan (Tag.)	Fresh	5	81.21	0.58	4.60	0.14	0.027
	Dippig (Ilk.); saba (Tag.); seba (Pang.)	Fresh	6	80.81	0.60	5.75	0.18	0.034
	Lacatan	Fresh	4	78.23	0.63	5.01	0.15	0.032
	Average							0.030
4.	Breadfruit, *Artocarpus communis* Forst.	Fresh	3	66.72	1.13	7.52	0.26	0.090
5.	Camias (Tag.); pias (Pang., Ilk.), *Averrhoa bilimbi* L.	Fresh	3	92.02	0.32	1.58	0.06	0.005
6.	Chico, *Achras sapota* L.	Fresh	7	78.31	0.61	2.97	0.07	0.015
7.	Coconut (meat only), *Cocos nucifera* L.	Fresh	6	14.82	1.93	4.92	0.11	0.100
8.	Coffee, *Coffea* sp.	Roasted	3	8.12	3.12	6.89	0.23	0.220
9.	Cucumber, *Cucumis sativus* L.	Fresh	7	94.33	0.72	4.92	0.62	0.036
10.	Guava, *Psidium guajava* L.	Fresh	5	81.82	0.73	4.17	0.17	0.031
11.	Guyabano, *Anona muricata* L.	Fresh	5	96.82	0.21	0.91	0.06	0.002
12.	Lansones (Tag.), *Lansium domesticum* Correa.	Fresh	8	86.21	0.73	0.51	0.03	0.004
13.	Mabolo, *Diospyros discolor* Willd.	Fresh, ripe	3	82.13	0.70	1.38	0.06	0.010
14.	Mango, *Mangifera indica* L.	Fresh, ripe	5	86.75	0.39	2.81	0.08	0.011
15.	Naranjita, *Citrus nobilis* Lour.	Fresh, ripe	4	82.40	0.33	24.24	0.64	0.080
16.	Lukban, *Citrus maxima* (Burm.) Merr.	Fresh, ripe	5	88.83	0.41	21.67	0.80	0.089
17.	Papaya, *Carica papaya* L.							
	Sulu	Fresh, ripe	5	90.74	0.62	5.30	0.36	0.033
	Hawaii	Fresh, ripe	5	88.25	0.58	5.63	0.28	0.033
	Native	Fresh, ripe	5	85.25	0.70	7.69	0.37	0.054
	Pinacuan	Fresh, ripe	2	91.08	0.66	2.37	0.18	0.016
	Average							0.034
18.	Pineapple, *Ananas comosus* (L.) Merr.							
	Native	Fresh, ripe	3	88.81	0.51	2.08	0.12	0.012
	Hawaiian	Fresh, ripe	2	91.83	0.47	1.54	0.09	0.007
	Cayenne	Fresh, ripe	2	90.72	0.58	1.97	0.13	0.011
	Average							0.010
19.	Watermelon, *Citrullus vulgaris* Schrad.	Fresh, ripe	2	90.21	0.52	15.42	0.81	0.079
20.	Sapote, *Diospyros ebenaster* Retz.	Fresh, ripe	2	84.55	0.43	1.78	0.05	0.008
	Legumes							
1.	Camanchili (Tag.); kamantiris (Ilk.); *Pithecolobium dulce* (Roxb.) Benth	Fresh	3	93.81	0.84	2.91	0.40	0.025
2.	Tamarind, *Tamarindus indica* L.	Fresh	3	79.72	0.58	1.97	0.13	0.011

TABLE 4

The percentages of moisture, ash, and calcium oxide in meat products

NAME OF FOOD	CONDITION OF SAMPLE	NO. OF ANALYSES	MOISTURE	ASH	CALCIUM OXIDE IN:		
					Ash	Dry material	Sample as analyzed
			per cent	*per cent*	*per cent*	*per cent*	*per cent*
1. Beef:							
Lean	Fresh	5	67.23	0.68	1.71	0.04	0.013
Corned	Canned	2	50.88	2.23	0.74	0.03	0.018
2. Eggs:							
Chicken, *Gallers gallus*	Fresh	12	70.32	0.78	10.24	0.34	0.199
Duck	Fresh	10	69.91	1.12	11.35	0.42	0.127
Average							0.163
3. Hoppers; lucton (Ilk., Pang., Tag.), *Pachytylus migratoroides*	Fresh	2	75.97	1.88	4.55	0.36	0.085
4. Locust; dodon (Ilk.); duron (Pang.), *Pachytylus migratoroides*	Fresh	2	63.31	3.12	6.53	0.55	0.200
5. Pork: lean	Fresh	8	54.81	0.72	1.54	1.02	0.011

TABLE 5

The percentages of moisture, ash, and calcium oxide in milk and other dairy products

NAME OF FOOD	CONDITION OF SAMPLE	NO. OF ANALYSES	MOISTURE	ASH	CALCIUM OXIDE IN:		
					Ash	Dry material	Sample as analyzed
			per cent	*per cent*	*per cent*	*per cent*	*per cent*
1. Butter	Canned	2	21.32	5.11	0.43	0.03	0.022
2. Cheese:							
Imported	Canned	3	35.12	5.27	23.18	2.03	1.321
San Pedro Tunasan	Fresh	5	46.32	5.21	20.13	1.96	1.054
Average							1.188
3. Oleomargarine	Canned	2	12.10	5.51	0.46	0.03	0.026
4. Milk:							
Cow	Fresh	10	90.12	0.34	22.09	0.75	0.075
Carabao	Fresh	6	89.33	0.41	21.52	0.89	0.088
Condensed Bernese Alps Milkmaid	Canned	3	48.86	0.52	20.82	0.21	0.108
Crescent Brand	Canned	2	88.72	0.45	19.81	0.79	0.089
Carnation Brand	Canned	2	89.02	0.36	20.04	0.64	0.072
Average							0.086

TABLE 6

Showing the percentages of moisture, ash, and calcium oxide in seeds

NAME OF FOOD	CONDITION OF SAMPLE	NO. OF ANALYSES	MOISTURE	ASH	CALCIUM OXIDE IN.		
					Ash	Dry material	Sample as analyzed
			per cent	*per cent*	*per cent*	*per cent*	*per cent*
1. Adlay, *Coix lachryma-jobi* L.:							
Batangas brown	Air dry	2	11.33	1.02	1.03	0.01	0.010
Black, C. N. 17293	Air dry	4	13.00	1.09	1.78	0.02	0.020
Lamao brown	Air dry	2	10.24	0.69	1.82	0.01	0.013
Mountain Province	Air dry	4	14.01	0.80	2.19	0.02	0.018
White, C. N. 17294	Air dry	3	12.89	0.95	1.48	0.02	0.014
Average							0.015
2. Corn; maize, *Zea mays* L.:							
Calauang Yellow Flint	Air dry	5	13.69	1.70	1.28	0.03	0.022
Calauang Yellow Flint	Fresh	2	73.91	0.63	0.90	0.02	0.006
Dent	Air dry	4	12.81	1.32	1.17	0.02	0.014
Dent	Fresh	2	71.21	0.48	0.74	0.01	0.004
Mexican June	Air dry	3	12.82	1.12	1.52	0.02	0.017
Moro	Air dry	3	13.03	1.22	1.45	0.02	0.018
Mosby	Air dry	4	12.57	1.70	1.64	0.03	0.028
Sweet	Air dry	4	13.12	1.31	0.95	0.01	0.013
Wermea Yellow	Air dry	2	11.95	2.44	1.02	0.03	0.025
Average							0.016
3. Rice, *Oryza sativa* L.:							
Apostol	Air dry	5	13.67	0.91	1.60	0.02	0.051
Binicol	Air dry	5	14.21	1.12	0.87	0.01	0.010
Bulilising	Air dry	5	14.08	1.21	0.87	0.01	0.011
Calibo	Air dry	5	13.12	1.08	1.49	0.02	0.016
Daluson	Air dry	5	13.73	0.98	1.89	0.02	0.019
Inantipolo	Air dry	5	13.12	1.12	1.70	0.02	0.019
Iroy	Air dry	5	13.42	1.18	1.45	0.02	0.017
Lumbang	Air dry	5	14.13	1.21	1.33	0.02	0.016
Saba	Air dry	5	13.73	1.25	1.28	0.02	0.016
Average							0.019
Legumes							
1. Cowpea, *Vigna sinensis* (L.) Saviex Hassk.	Air dry	5	13.12	3.21	4.16	0.16	0.133
2. Lima bean, *Phaseolus lunatus* L.	Air dry	5	12.23	3.80	5.70	0.25	0.216
3. Mungo (Tag.); balatong (Ilk., Pang.), *Phaseolus aureus* Roxb.	Air dry	5	13.53	3.60	4.38	0.20	0.185
4. Peanut, *Arachis hypogæa* L.:							
American C. N. 109	Air dry	5	10.01	2.37	3.17	0.79	0.075
Chinese C. N. 6034	Air dry	5	8.59	2.75	4.40	0.13	0.121
Javanese C. N. 3901	Air dry	5	5.73	2.44	4.67	0.12	0.114
Kinorales C. N. 3083	Air dry	5	5.86	2.70	4.38	0.13	0.118
Native Lemergy C. N. 3082	Air dry	5	6.14	2.48	5.02	0.13	0.125
Spanish C. N. 3166	Air dry	5	5.88	2.65	3.92	0.09	0.091
Valencia	Air dry	5	6.46	2.68	3.55	0.10	0.095
Vigna Lupog C. N. 6889	Air dry	5	7.13	2.87	4.04	0.12	0.116
Zambales C. N. 6688	Air dry	5	6.95	2.49	3.32	0.09	0.048
Average							0.116
5. Soy bean, *Glycine max* (L.) Merr.	Air dry	5	9.20	4.75	5.42	0.29	0.257
6. Jack bean, *Canavalia ensiformis* (L.) Dc.	Air dry	5	14.49	3.36	7.11	0.28	0.239
7. Velvet bean, *Mucuna deeringiana* (Bort.) Merr.	Air dry	5	15.12	4.10	6.23	0.30	0.257

TABLE 7

Showing percentages of moisture, ash, and calcium oxide in tubers and bulbs

	NAME OF FOOD	CONDITION OF SAMPLE	NO. OF ANALYSES	MOISTURE	ASH	CALCIUM OXIDE IN:		
						Ash	Dry material	Sample as analyzed
				per cent	*per cent*	*per cent*	*per cent*	*per cent*
1.	Carrot, *Daucus carota* L.	Air dry	2	89 14	0 17	0 70	0 70	0 076
2.	Cassava; camoteng-cahoy (Tag.); kamote ti Moro (Ilk.), *Manihot utilissima* Pohl	Air dry	5	58 91	0 40	8 23	0 08	0 033
3.	Gabi (Tag.); aba (Ilk., Pang.) *Colocasia esculentum* (L.) Schott	Air dry	5	58 53	0 57	6 82	0 69	0 039
4.	Garlic, *Allium sativum* L.	Air dry	4	83 12	1 11	1 93	0 07	0 012
5.	Ginger, *Zingiber officinale* Rosco	Air dry	3	70 18	1 22	1 2.	0 05	0 026
6.	Onion, *Allium cepa* L.:							
	Native small; lasona (Ilk., Pang., Tag.)	Air dry	3	73 24	1 82	3 53	0 24	0 065
	Native big; sibuyas (Ilk., Pang., Tag.)	Air dry	2	78 56	2 12	2 92	0 27	0 062
	Average							0 064
7.	Potato, *Solanum tuberosum* L.	Air dry	3	76 47	0 33	3 03	0 07	0 017
8.	Radish, *Raphanus sativus* L.	Fresh	5	92 03	1 02	0 29	0 29	0 023
9.	Sweet potato, *Ipomœa batatas* L.	Air dry	3	59 11	0 62	1 37	0 07	0 027
10.	Ubi, *Dioscorea alata* L.	Air dry	4	63 68	0 51	9 22	0 10	0 048
11.	Yam, *Dioscorea esculenta* (Lour.) Burkill	Fresh	3	60 83	0 47	2 98	0 10	0 037

TABLE 8

The percentages of moisture, ash, and calcium oxide in the vegetables

	NAME OF FOOD	CONDITION OF SAMPLE	NO. OF ANALYSES	MOISTURE	ASH	CALCIUM OXIDE IN:		
						Ash	Dry material	Sample as analyzed
				per cent	*per cent*	*per cent*	*per cent*	*per cent*
	Non-leguminous							
1.	Ampalaya (Tag.); paria (Ilk.); palia (Pang.), *Momordica charantia* L.	Fresh	7	92 21	1.02	3.86	0.55	0 040
2.	Banana "heart", puso, *Musa sapientum* L.	Fresh	2	80.21	1.01	4.16	0 21	0.042
3.	Cabbage, *Brassica oleracea* L.	Fresh	3	91 01	0.82	8.06	0 84	0.067
4.	Calabasa fruits, *Cucurbita maxima* Duchesne	Fresh	8	93.86	0.49	4.37	0 30	0 021
5.	Calabasa shoots, *Cucurbita maxima* Duchesne	Fresh	15	88.82	1.38	1 52	0.19	0 021
6.	Cangcong shoots, *Ipomœa reptans* (L.) Poir	Fresh	10	29.23	1.20	1.22	0.14	0.015
7.	Eggplant, *Solanum melongena* L.:							
	American	Fresh	7	93.00	0 60	11.78	1.01	0.070
	Native oblong	Fresh	9	93 10	0.61	11.61	1.03	0.071
	Native purple	Fresh	6	91.28	0 57	8.76	0.58	0.050
	Native white	Fresh	3	92.12	0.55	9 67	0 68	0.053
8.	Himbabá-a (Tag.); baeg (Ilk., Pang.) flowers, *Allœanthus luzonicus* (Blanco) F.–Vill	Fresh	8	78.92	1.88	4.47	0.40	0.084
9.	Himbabá-a (Tag.); baeg (Ilk., Pang.) shoots, *Allœanthus luzonicus* (Blanco) F.–Vill	Fresh	10	73.42	2 21	4.46	0.37	0.099
	Average							0 [illegible]
10.	Endive	Fresh	3	91.32	0.90	15.72	1.75	0.142
11.	Garlic leaves, *Allium sativum* L.	Fresh	5	92 91	0.72	1.36	0 14	0.010
12.	Lettuce, *Lactuca sativa* L.	Fresh	3	94 31	0.71	7.60	0 95	0.054
13.	Mustard leaves, *Brassica integrifolia* (West), O. E. Schulz	Fresh	4	92.42	0 81	8.62	0.91	0.069
14.	Onion leaves, *Allium cepa* L.	Fresh	5	92.61	0.78	1.05	0.13	0.008
15.	Paco leaves, *Athyrium esculentum* Copel	Fresh	8	90 00	1 23	2 31	0 28	0.029
16.	Patola fruit, *Luffa cylindrica* (L.) M. Roem	Fresh	2	88.72	0.43	2.46	0.13	0.015
17.	Pechay leaves, *Brassica cernua* (Thunb.) Forbes and Hemsl	Fresh	4	91 01	0.85	5 46	0 52	0.047
18.	Pepper; green fruit, *Capsicum annum* L.	Fresh	5	68 91	0.98	0 98	0.06	0.010
19.	Pepper, Chile leaves, *Capsicum frutescens* L.	Fresh	8	92.00	1.01	1.01	0.13	0.010
20.	Papaya, *Carica papaya* L.:							
	Sulu	Fresh	5	93.81	0.51	4.05	0 34	0.021
	Hawaii	Fresh	5	91 87	0 43	3.11	0.17	0.014
	Native	Fresh	5	88 10	0.63	4.97	0.27	0.032
	Average							0 [illegible]
21.	Tomato, *Lycopersicum esculentum* Mill.:							
	Native small	Fresh, ripe	5	94.32	0.06	2.84	0.03	0.002
	Native big	Fresh, ripe	3	93.80	0.09	2.52	0.04	0.003
	Average							0 003
22.	Upo (Tag.); tabuñgao (Ilk., Pang.), *Lagenaria leucantha* (Duch.) Rusby:							
	Long	Fresh	4	94 79	0.44	13.45	1.14	0.059
	Oval	Fresh	2	93.21	0.50	10.17	0.75	0.051
	Average							0 050
	Leguminous							
1.	Caturay (Pang., Tag.); Catudai (Ilk.) flowers, *Sesbania grandiflora* L. Pers.	Fresh	9	83.63	0.92	2.49	0.14	0.023
2.	Cowpea pods, *Vigna sinensis* (L.) Savi ex Hassk.	Fresh	12	80.62	2.42	1.72	0.21	0.042
3.	Maluñgay (Pang., Tag.); maruñgai (Ilk.) leaves, *Moringa oleifera* Lam.	Fresh	18	77.50	2.05	7.31	0.67	0.150
4.	Maluñgai (Pang., Tag.); maruñgai (Ilk.) fruits, *Moringa oleifera* Lam.	Fresh	10	68 23	1.12	4.45	0.16	0.050
5.	Mungo (Tag.); balatong (Ilk., Pang.) pods, *Phaseolus aurens* Roxb.	Fresh	13	78.31	3.01	2.12	0.29	0.064
6.	Pea pods, *Pisum sativum*, L.	Fresh	15	80.13	1.83	1.84	0.17	0.034
7.	Soybean pods, *Glycine max* (L.) Merr.	Fresh	16	80.81	2 23	2.24	0.25	0.050

WEEDS IN THE RICE FIELDS AND THEIR EFFECT ON THE YIELD OF GRAIN[1]

BENJAMIN C. CABAILO

WITH THREE TEXT FIGURES

INTRODUCTION

No systematic study of weeds in the Philippines has been published except a general survey of some of our common weeds by Quisumbing (1923).

The experiment on weeds in the rice fields reported in this paper was limited in scope, but it may serve as a working plan for future studies on a larger scale.

Review of literature

The literature from the Philippines on the effects of weeds on rice is limited. Practically no work has been performed with sufficient control. Quisumbing (1923) was the first to investigate weeds that are common. Later, this same author (1924) conducted experiments on the methods of eradication and control of *Marsilea crenata* Presl., a noxious weed in the rice fields, and determined the effect of this weed on the yield of grain.

Considerable work on weeds in rice fields has been done the last twenty-five years in other rice growing countries. Knapp (1900) found that in planting rice, the land should be free from red rice and other weeds. Bolley (1908) stated that weeds reduce the yield of farm crops by crowding the crop and by removing food solution necessary to the plants. Laude (1918) who worked on the control of weeds in rice fields of Texas found that decrease in yields was the case where no cultivation was given, and when the field was kept free from weeds by cultivation, much larger yields were produced. Tarchetti (1918) who worked on the control of weeds by means of rolling had good results. He was successful in his method of control in the one year old rice field. Chamblis (1920) found that crop losses due to barnyard grass, the red rice, and the Mexican weed are enormous. These weeds, according to his reports, are the most difficult to control and eradicate. Cox (1922) found that weeds reduce yields, as they deprive the crops of moisture, plant food, and sunlight. Dunshee (1923) found that in the plots submerged eight inches, no barnyard grass appeared above the surface of the water, but plots submerged two inches were very foul with barnyard grass. He found *Scirpus occidentales, Eleocharis palustris, Cyperus virens, Cyperus difformis, Syntherisma sanguinalis, Polygonum tapathifolium, Typha latifolia* to be common noxious weeds in rice fields. Kennedy (1923) observed rice weeds in California and found *Echinochloa crus-galli, Paspalum distichum, Leptochloa fascicularis, Phalaris paradoxa, Phalaris brachystachys, Phalaris minor, Leersia oryzoides, Polypogon monspeliensis, Setaria viridis, Cyperus virens, Cyperus difformis, Typha latifolia, Sagittaria latifolia* to be common. Dunshee and Jones

[1]Thesis presented for graduation, 1925, with the Degree of Bachelor of Science in Agriculture, No. 209; Experiment Station contribution No. 321; Prepared in the Department of Plant Physiology under the direction of Assistant Professor Eduardo Quisumbing.

(1924) worked out an experiment at Cortena and at Biggs Rice Field Station, California. The newly planted rice plants were irrigated moderately about four weeks before the field was flooded. Shallow water from two to four inches deep did not control the weeds, but from six to eight inches aided in controlling the water grass (*Echinochloa crus-galli*), but this depth suffocated so much rice that low yields were produced.

Mendiola (1924) in his report on a visit to Java states that the yield of rice may be increased by different systems of weeding and planting. Koch (1918-1919) determined the effects of what he termed intensive weeding, no weeding, and common weeding on the yield of four lowland varieties of rice. Intensive weeding consisted of kneading the ground between the plants once with the feet, hand weeding and trampling the collected weeds, and finally working the ground with the weeding hoe. Common weeding was similar to intensive weeding with the omission of the final step, that is of the working of the ground with the hoe. Intensive weeding in each case, gave a higher production than no weeding, and about the same production as common weeding. With one variety, Koch determined the effect of performing the common weeding two times, comparing this treatment with common weeding one time only. There was a difference of 6.2 piculs of dry grain per bouw (Javan picul equals 61.76 kilograms and a bouw equals 70 ares and 96 centares) in favor of two times common weeding. With two other varieties, no weeding was compared with common weeding two times and common weeding three times plus hoeing. The yield of dry padi (paddy) per bouw for the different treatments was as follows: of variety Pandan, 44.4 piculs, 51.2 piculs, and 57.1 piculs, for the first, second, and third systems of weeding, respectively. In variety Pelak, the corresponding yields were 44.7 piculs, 45.3 piculs, and 45.9 piculs.

Object of the present work

The objects of this study were: (*a*) To determine whether increased yield of rice in lowland, upland, and caiñgin fields would be obtained by controlling and eradicating the weeds; (*b*) To determine the troublesome weeds in rice fields; and (*c*) To find whether weeds found in one habitat are also found in other habitats.

Time and place of the present work

The investigation was begun in April, 1923, and closed in November, 1924. The experiment was conducted in the rice paddies of Bay, Laguna, and in the upland and caiñgin fields near the College of Agriculture, in Los Baños, Laguna.

MATERIALS AND METHODS

This piece of work was carried out under three systems: caiñgin, upland, and lowland. Two separate crops were grown under each system. The method of preparation of the land was similar to the methods commonly used in the locality. After the rice plants had started, weekly observations of the weeds were made. During the progress of the work, the weeds were collected and studied.

Preparation of the land

Caiñgin culture. In the caiñgin system the field was prepared for planting in the usual way. First, the large trees were cut down, then the weeds

were cut, dried, and burned. Rice seeds were planted by the *bacal* method, at a distance of 25 cm. each way. The variety Inabaca was used in the first set and variety Quinaluscus in the second set.

Upland culture. In the upland culture the land was plowed and harrowed following the common practice. In the beginning of the rainy season when the field was properly prepared, the seeds were broadcasted uniformly in the furrows. The seed was covered by harrowing. The variety used in the first set was Binicol and in the second, Inintiw.

Lowland culture. The land was irrigated before plowing and harrowing. Seedlings about three to four weeks old were transplanted from the seed-bed. A week or two after the planting, the plots were flooded to the depth of 7.62 centimeters. This depth was maintained in the plots until the rice was fully matured. The water was drained off thoroughly before harvest. The variety planted in the first set was Dinagat and in the second, Guinangang.

Treatment of plot

The same procedure was used in caiñgin, upland, and lowland cultures. The field was divided into three plots, A. B, and C, of 100 square meters each. Plot A was intensively weeded by hoeing and hand weeding during the season. From the time of planting up to harvesting the plot was hoed three times and weeded by hand twice. Plot B was weeded only once, when the plants were from 45 to 61 centimeters in height. This is the usual amount of weeding that Filipino farmers give. Plot C was not weeded at all.

Weed flora in each plot

The weed flora and the density of weeds in each plot were determined by the quadrat method. Before cleaning the field, the flora present in each of the three plots was determined, including the relative abundance of each species, characteristics, and habit of growth. Weeds in plots A and B were taken to the laboratory for identification, while weeds in plot C were not removed but studied and identified on the spot. This procedure and plan of study was applied to all three systems of culture: caiñgin, upland, and lowland.

Yield

To obtain the yield all the plants in each plot were harvested. The plants were cut close to the ground and the weight recorded. Then they were taken to the laboratory, the harvest from each plot in separate sacks. After threshing on a cement floor, the weights of grain and straw were determined separately. The grain was winnowed and the fully developed grains measured in liters and the yield per hectare computed. The above procedure was applied to all three fields.

EXPERIMENTS AND RESULTS

Caiñgin yield

Table 1 gives the actual yield in liters per 100 square meters, the computed yield in terms of cavans (1 cavan = 75 liters) per hectare and the total weight of straw obtained from each of the two sets of experiment. In the first set, plot A yielded 13.34 cavans more than plot B; and plot B yielded 4 cavans more than plot C. In the second set, plot A yielded 9 cavans more than plot B; and plot B yielded 5 cavans more than plot C.

Table 2 gives the average computed yield in terms of cavans and the weight of straw per hectare in the two sets of experiments. Plot A yielded 11.17 cavans more than plot B; and plot B yielded 4.5 cavans more than plot C.

TABLE 1

Showing yields of rice as affected by weeds

GROWING SEASON	PLOTS	AREA PLANTED	YIELDS			DIFFERENCE IN PERCENTAGE	WT. OF STRAW
			Actual	Per Ha.	Diff.		
First set		*sq. m.*	*liters*	*cavans*	*cavans*		*grams*
January 19, 1923	A	100	17	22.67		100	70.60
to	B	100	7	9.33	13.34	41	38.20
October 26, 1923	C	100	4	5.33	4.00	24	29.10
Second set							
June 20, 1924	A	100	22.50	30.00		100	85.30
to	B	100	15.70	21.00	9.00	70	79.40
November 8, 1924	C	100	12.00	16.00	5.00	53.33	68.50

TABLE 2

Showing the average yield of two harvests

PLOTS	AREA PLANTED	YIELDS			DIFFERENCE IN PERCENTAGE	WEIGHT OF STRAW
		Actual	Per Ha.	Diff.		
	sq. m.	*liters*	*cavans*	*cavans*		*grams*
A	100	19.75	26.335		100	77.95
B	100	11.35	15.165	11.170	57.58	58.80
C	100	8.00	10.665	4.500	49.49	48.80

Upland yield

Table 3 gives the actual yields in liters per 100 square meters; the computed yield in cavans per hectare and the total weight of straw obtained from each of the two sets of the experiments. In the first set, plot A yielded 2.67 cavans more than plot B; and plot B yielded 13.33 cavans more than plot C. In the second set, plot A yielded 1.3 cavans more than plot B; and plot B yielded 6.7 cavans more than plot C.

Table 4 gives the average computed yield in cavans and the weight of straw per hectare in each of the two sets of the experiment. Plot A yielded 1.985 cavans more than plot B; and plot B yielded 10.015 cavans more than plot C.

TABLE 3

Showing yields of rice as affected by weeds

GROWING SEASON	PLOTS	AREA PLANTED	YIELDS			DIFFERENCE IN PERCENTAGE	WT. OF STRAW
			Actual	Per Ha.	Diff.		
First set		*sq. m.*	*liters*	*cavans*	*cavans*		*grams*
June 30, 1923	A	100	24	32.00		100	99.80
to	B	100	22	29.33	2.67	91.65	91.40
November 3, 1923	C	100	12	16.00	13.33	50.00	53.20
Second set							
June 24, 1924	A	100	21	28.00		100	82.10
to	B	100	19	26.70	1.30	93.35	73.80
October 3, 1924	C	100	15	20.00	6.70	71.43	69.40

TABLE 4

Showing the average yield of two harvests

PLOTS	AREA PLANTED	YIELDS			DIFFERENCE IN PERCENTAGE	WEIGHT OF STRAW
		Actual	Per Ha.	Diff.		
	sq. m.	*liters*	*cavans*	*cavans*		*grams*
A	100	22.5	30.000		100	90.95
B	100	20.5	28.015	1.985	93.38	82.60
C	100	13.5	18.000	10.015	60.00	61.30

Lowland yield

Table 5 gives the actual yield in liters per 100 square meters and the computed yield in terms of cavans per hectare and the total weight of straw obtained from each of the two sets of the experiments. In the first set, plot A yielded 2.67 cavans more than plot B; and plot B yielded 3.5 cavans more than plot C. In the second set, plot A yielded 12.67 cavans more than plot B; and plot B yielded 4.67 cavans more than plot C.

Table 6 gives the average computed yield in terms of cavans and the weight of straw per hectare in each of the two sets of the experiments. Plot A yielded 7.67 cavans more than plot B; and plot B yielded 4.08 cavans more than plot C.

TABLE 5

Showing yields of rice as affected by weeds

GROWING SEASON	PLOTS	AREA PLANTED	YIELDS			DIFFERENCE IN PERCENTAGE	WT. OF STRAW
			Actual	Per Ha.	Diff.		
First set		*sq. m.*	*liters*	*cavans*	*cavans*		*grams*
July 8, 1924	A	100	29.00	38.67		100	115.20
to	B	100	27.00	36.00	2.67	93.09	103.80
October 15, 1924	C	100	25.00	32.50	3.50	84.04	99.30
Second set							
January 4, 1924	A	100	37.00	49.33		100	125.60
to	B	100	29.00	36.67	12.67	74.33	113.80
May 15, 1924	C	100	24.00	32.00	4.67	64.86	110.20

TABLE 6

Showing the average yield of two harvests

PLOTS	AREA PLANTED	YIELDS			DIFFERENCE IN PERCENTAGE	WT. OF STRAW
		Actual	Per Ha.	Diff.		
	sq. m.	*liters*	*cavans*	*cavans*		*grams*
A	100	33.00	44.00		100.00	120.40
B	100	28.00	36.33	7.67	82.57	108.80
C	100	24.50	32.25	4.08	73.29	104.75

DISCUSSION OF RESULTS

Yields of rice as affected by weeds

Judging from the results obtained (see tables 1 to 6), the effects of weeds on the yields of rice were very marked. The yield in grain was found to be proportional to the care given; that is, plots where plants were well cared for and weeded, gave the highest yield; plots that were not weeded at all gave the lowest yield.

In all trials, production was found highest in plot A, which received five weedings during the growing season. Plot B which received one weeding, only, gave better production than plot C with no weeding. The yields in the two sets were not the same but the ratio is nearly the same. The difference in the yield of the two sets was due in part to the difference in locality and climatic conditions and in the lowland field to different varieties used.

In addition to weeding used in the three habitats, the lowland field through irrigation had the advantage of the presence of water throughout the vegetative growth of rice. The presence of the water aided materially in the control of weeds.

Caiñgin. In the first set, the yields per hectare from plots A, B, and C of caiñgin fields were 22.67 cavans; 9.33 cavans; and 5.33 cavans, respectively; in the second set, 30 cavans, 21 cavans, and 16 cavans, respectively. The average yield per hectare of plot A was 26.335 cavans; of plot B, 15.165 cavans; and of plot C, 10.665 cavans. All three plots received the same degree of care in the preparation of the land, so at the start the plants were given the same chance for growth. Then the marked differences in the yields from plots A, B, and C must be due to the varying amounts of cultivation given after planting. In plot A, the weeds were pulled up and the plot hoed three times; plot B was weeded only once; plot C was not weeded at all. (See fig. 1.)

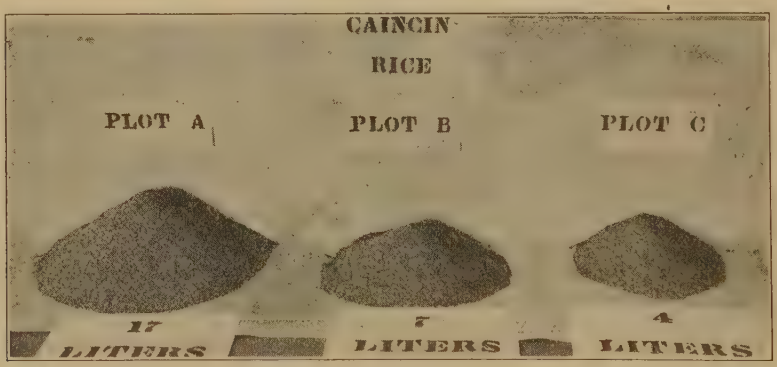

Fig. 1. Showing actual yields in terms of liters from plots A, B, and C from caiñgin field (first set).

Upland. In the first set the yield per hectare obtained from plots A, B, and C of the upland culture were 32.0 cavans, 29.33 cavans, and 16.0 cavans, respectively; in the second set, 28 cavans, 26.7 cavans, and 20.0 cavans. The average yield per hectare of plot A was 30.0 cavans; of plot B, 28.015 cavans; and of plot C, 18 cavans. The slight difference in the yield from plots A and B was due to the more intensive weeding given to plot A. Plot C received the same preparation of the land as plots A and B, but no weeding, consequently a relatively low yield. On the whole, the yield from the upland fields was more than from the caiñgin field. This is accounted for by the better preparation of the upland plots. Nothing in the way of tilling was done on the caiñgin save the digging of the holes into which the seeds were dropped and then covered. The cultural

attention given to the plants at the start in the upland field indirectly prevented the early growth of weeds. The difference of varieties used may be ascribed as another reason for better yield. (See fig. 2.)

Fig. 2. Showing actual yields in terms of liters from plots A, B, and C from upland field (first set).

Lowland. In the first set the yields per hectare obtained from plots A, B, and C of the lowland cultures were 38.67 cavans, 36.0 cavans, and 32.50 cavans, respectively; in the second set, 49.33 cavans, 36.67 cavans, and 32 cavans, respectively. The average in yield per hectare of plot A was 44 cavans; of plot B, 36.33 cavans; and of plot C, 32.25 cavans. There were no marked differences in yield from the three plots. Water which was always present in the plots during the vegetative growth of the rice plants is itself an agent in killing the weeds. The only weeds which survived the submergence were of the aquatic or amphibious kinds. Thus the weeds were limited to a few species, and in plots where intensive weeding was done, they were practically eliminated. (See fig. 3.)

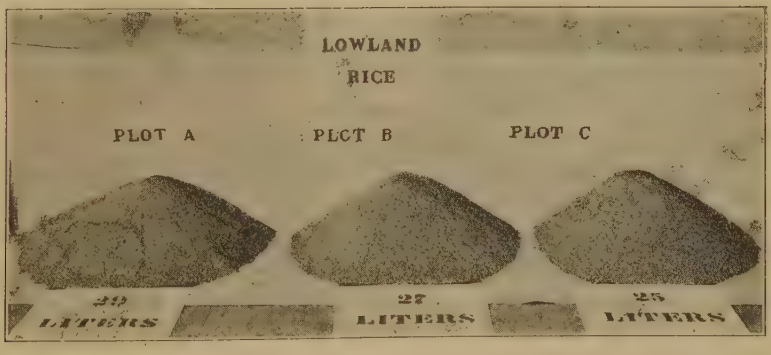

Fig. 3. Showing actual yields in terms of liters from plots A, B, and C from lowland field (first set).

Weed flora

From table 7 it may be seen that the weed flora of the fields is comprised of several plant families and is exceedingly rich in species. The distribution of the species in the three habitats depends upon the condition of the soil and the preparation of the land. Different species were present in each habitat. Water-

loving species of weeds were found in limited numbers in the fields that were wet. Dominant species in the lowland fields were not found to be dominant in either the upland or the caiñgin fields, but dominant species in these two fields were about the same.

Caiñgin. The caiñgin lots were very rich in weed flora, the richest of the three types of fields. With the exception of family Pontederiaceae, all the families enumerated in table 7 were well represented in one, two, or even in all of the plots, and constitute 82 species and 468 individuals in all. These results are partly due to the lands being virgin, as is usually true of caiñgin lands. Since no plowing or harrowing or any cultural treatment was given the lots, the weeds were not killed; cutting them only temporarily stopped their growth. The dominant species in their order of abundance were: *Synedrella nodiflora* (Linn.) Gaertn., *Mimosa pudica* Linn., *Imperata cylindrica* var. *koenigii* (Retz.) Benth., *Saccharum spontaneum* sub. sp. *indicum* Hack., and *Paspalum conjugatum* Berg.

Upland. These plots had fewer species of weeds than the caiñgin but more than the lowland plots. Plowing and harrowing helped control the growth of the weeds, possibly some seeds were buried deep enough to kill them. Of the sixteen families found in the three habitats, fourteen were represented in these fields; they comprised 73 species and 417 individuals. The dominant species in the order of their abundance were: *Amaranthus spinosus* Linn., *Synedrella nodiflora* (Linn.) Gaertn., *Malachra capitata* Linn., *Eclipta alba* (Linn.) Hassk., and *Paspalum conjugatum* Berg.

Lowland. The plots of the lowland culture had the fewest families and species of the three types of fields. The thorough preparation of the land, the subsequent soaking, together with the continuous presence of water in the lots during the vegetative growth of the rice plants, formed an effective means of weed control. Only a few families, which are either amphibious or aquatic in character, are able to grow under such conditions. Of the sixteen families, only eight were well represented; these constituted a total number of 46 species and 397 individuals. The most dominant species in the order of their abundance were: *Panicum crus-galli* Linn., *Cyperus difformis* Linn., *Monochoria vaginalis* (Burm. f.) Presl., *Fimbrystilis complanata* (Retz.) Link., and *Synedrella nodiflora* (Linn.) Gaertn.

There was a wide difference in abundance of the weeds in the three habitats (see table 8). Species found dominant in the lowland fields occurred in a negligible number in the upland and caiñgin fields. In the lowland field, with a few exceptions, the species belonged mostly to the Gramineæ and Cyperaceæ families. Some weeds which occurred in both caiñgin and upland fields gained ground in the lowland plots only after the water was drained off before harvesting. Some of the weeds in the upland and caiñgin cultures are drought resistant; so these fields afforded a good medium for their growth. The weeds in these fields were nearly identical in distribution as well as in dominant species.

SUMMARY

1. In the caiñgin field the yield per hectare in the first set from plot A which was weeded five times was 22.67 cavans; from plot B, which received only one weeding, 9.33 cavans; and from plot C, which received no weeding at all, 5.33 cavans. In the second set the yield from plot A was 30 cavans; from plot B, 21

cavans; and from plot C, 16 cavans. The average of the yields per hectare of the two sets was 26.335 cavans for plot A; 15.165 cavans for plot B; and 10.665 cavans for plot C.

2. In the upland field the yield per hectare in the first set from plot A, which was weeded five times, was 32 cavans; from plot B, which received only one weeding, 29.33 cavans; and plot C, which received no weeding at all, 16 cavans. In the second set the yield from plot A was 28 cavans; from plot B, 26.7 cavans; and from plot C, 20 cavans. The average of the yields per hectare of the two sets was 30 cavans for plot A; 28.015 cavans for plot B; and 18 cavans for plot C.

3. In the lowland fields the yield per hectare in the first set from plot A, which was weeded five times, was 38.67 cavans; from plot B, which received only one weeding, 36 cavans; and from plot C, which received no weeding at all, 32.50. In the second set the yield from plot A was 49.33 cavans; from plot B, 36.67 cavans; and from plot C, 32 cavans. The average yield per hectare of the two sets was 44 cavans for plot A; 36.33 cavans for plot B; and 32.25 cavans for plot C.

4. The weight of straw was proportional to the yield of grain.

5. The caiñgin field had 15 families, 82 species, and 468 individuals of weeds. The upland field had 14 families, 73 species, and 417 individuals. The lowland field had 8 families, 46 species, and 397 individuals.

6. The dominant species in the caiñgin field in the order of their abundance were: *Synedrella nodiflora* (Linn.) Gaertn., *Mimosa pudica* Linn., *Imperata cylindrica* var. *koenigii* (Retz.) Benth., *Saccharum spontaneum* sub. sp. *indicum* Hack., and *Paspalum conjugatum* Berg.

7. The dominant species in the upland field in the order of their abundance were: *Amaranthus spinosus* Linn., *Synedrella nodiflora* (Linn.) Gaertn., *Malachra capitata* Linn., *Eclipta alba* (Linn.) Hassk., and *Paspalum conjugatum* Berg.

8. The dominant species in the lowland field in the order of their abundance were: *Panicum crus-galli* Linn., *Cyperus difformis* Linn., *Monochoria vaginalis* (Burm. f.) Presl., *Fimbrystilis camplanata* (Retz.) Link., and *Synedrella nodiflora* (Linn.) Gaertn.

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ILLUSTRATIONS

Fig. 1. Showing actual yields in terms of liters from plots A, B, and C from caiñgin field (first set).

Fig. 2. Showing actual yields in terms of liters from plots A, B, and C from upland field (first set).

Fig. 3. Showing actual yields in terms of liters from plots A, B, and C from lowland field (first set).

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* = cultivated (escaped) weed; — = the absence

TABLE 8

Showing abundance of the different species of weeds in the three habitats

No.	WEEDS — Scientific name	FAMILY NAME	NUMBER OF SPECIES FOUND IN THE FIELD								
			Caingin			Upland			Lowland		
			Plot A	Plot B	Plot C	Plot A	Plot B	Plot C	Plot A	Plot B	Plot C
1	Lygodium japonicum (Thunb.) Sw.	Schizaceæ	—	1	1	—	—	—	—	—	—
2	L. flexuosum (Linn.) Sw.	do.	1	—	1	—	—	—	—	—	—
3	Imperata cylindrica var. koenigii (Retz.) Benth.	Gramineæ	15	3	14	—	—	1	—	—	—
4	Saccharum spontaneum subsp. indicum Hack.	do.	13	6	11	1	—	—	—	—	—
5	Andropogon halepensis var. propinquus (Kunth.) Merr.	do.	—	—	1	—	1	—	—	—	—
6	Paspalum vaginatum Sw.	do.	—	1	—	—	—	1	2	1	1
7	P. conjugatum Berg.	do.	3	7	18	4	11	8	1	2	1
8	P. longifolium Roxb.	do.	1	7	4	2	3	7	1	1	2
9	P. scrobiculatum Linn.	do.	1	—	3	—	—	—	—	—	—
10	Isachne miliacea Roth.	do.	—	—	—	—	—	—	1	—	1
11	Panicum crus-galli Linn.	do.	2	2	2	2	—	—	35	43	67
12	P. flavidum Retz.	do.	1	—	—	1	—	—	1	1	1
13	P. reptans Linn.	do.	1	—	—	—	1	—	1	1	1
14	P. carinatum Presl.	do.	—	—	2	—	1	2	—	—	—
15	P. nodosum Kunth.	do.	1	4	6	—	4	3	1	1	—
16	P. stagninum Retz.	do.	—	—	—	—	—	—	—	2	1
17	Setaria geniculata (Lam.) Beauv.	do.	2	—	1	—	—	1	—	—	—
18	Cynodon dactylon (Linn.) Pers.	do.	1	2	3	—	—	2	—	—	—
19	Eleusine indica (Linn.) Gaertn.	do.	3	—	—	—	1	1	1	2	1
20	Kyllinga monocephala Rottb.	Cyperaceæ	4	9	17	8	8	9	1	2	1
21	K. brevifolia Rottb.	do.	—	—	—	—	—	—	—	1	—
22	Cyperus uncinatus Poir.	do.	—	1	1	—	2	—	1	1	—
23	C. compressus Linn.	do.	—	—	7	—	1	4	1	1	—
24	C. iria Linn.	do.	3	—	1	1	1	1	1	2	1
25	C. difformis Linn.	do.	1	5	5	5	6	6	17	33	46
26	Fimbristylis annua All.	do.	1	1	—	—	1	3	2	1	1
27	F. complanata (Retz.) Link.	do.	2	4	2	3	5	3	1	3	9
28	F. miliacea (Linn.) Vahl.	do.	1	1	1	2	3	3	3	3	6
29	Scirpus grossus Linn. f.	do.	—	—	—	—	—	—	1	2	—
30	S. erectus Poir.	do.	—	—	—	—	—	—	—	1	—
31	Bulbostylis barbata (Rottb.) Kunth.	do.	—	3	4	4	2	1	3	3	4
32	Commelina nudiflora Linn.	Commelinaceæ	1	—	2	—	1	1	—	—	—
33	C. benghalensis Linn.	do.	—	—	1	—	1	1	—	—	—
34	Cyanotis cristata (Blume) C. B. Clarke	do.	—	—	1	—	1	1	—	—	—
35	Monochoria vaginalis (Burm f.) Presl.	Pontederiaceæ	—	—	—	—	—	—	11	4	3
36	Celosia argentea Linn.	Amaranthaceæ	1	1	2	1	—	1	2	1	1
37	Alternanthera sessilis (Linn.) R. Br.	do.	—	1	—	—	—	1	—	2	1
38	Amaranthus viridis Linn.	do.	1	1	4	—	3	3	—	—	—
39	A. spinosus Linn.	do.	1	1	4	27	18	12	—	—	—
40	Cyathula prostrata Linn. Bl.	do.	—	1	—	1	—	1	1	1	1
41	Portulaca oleracea Linn	Portulacaceæ	2	—	1	—	2	2	—	—	—
42	Gynandropsis gynandra (Linn.) Merr.	Capparidaceæ	2	7	2	2	2	1	—	—	—
43	Mimosa pudica Linn.	Leguminosæ	19	8	10	—	—	7	1	2	1
44	Cassia tora Linn.	do.	—	—	1	—	2	1	—	—	—
45	C. occidentalis Linn.	do.	—	—	1	—	3	-			
46	Aeschynomene indica Linn.	do.	1	—	1	—	—	1	1	—	1
47	Desmodium triflorum (Linn.) DC.	do.	1	—	1	—	1	1	—	—	—
48	D. gangeticum (Linn.) DC.	do.	2	—	—	—	—	2	—	—	—
49	Indigofera hirsuta Linn.	do.	1	1	3	—	3	1	—	—	—
50	I. suffruticosa Mill.	do.	—	—	2	—	—	1	—	—	—
51	Euphorbia hirta Linn.	Euphorbiaceæ	2	—	2	—	1	2	—	—	—
52	Phyllanthus niruri Linn.	do.	2	—	—	—	2	1	—	—	—
53	Corchorus capsularis Linn.	Tiliaceæ	3	2	1	2	2	2	2	4	4
54	C. olitorius Linn.	do.	—	1	—	—	1	—	1	2	1
55	Malachra capitata Linn.	Malvaceæ	1	2	2	14	13	8	—	—	—
56	Abutilon indicum (Linn.) Sweet	do.	2	—							
57	Urena lobata Linn.	do.	1	1	1	11	—	6	2	1	1
58	Kosteletzkya batacensis (Blanco) F.–Vill.	do.	1	—	1	—	—	1	—	—	—
59	Jussiaea linifolia Vahl.	Oenotheraceæ	1	—	1	—	—	1	—	—	—
60	Merremia gemella (Burn. f.) Hallier f.	Convolvulaceæ	1	1	3	—	—	3	—	—	
61	Hyptis suaveolens Poir.	Labiateæ	—	1	2	—	—	2	—	—	—
62	Leucas aspera (Willd.) Spreng.	do.	3	—	1	—	—	1	—	—	—
63	Ageratum conyzoides Linn.	Compositæ	1	—	2	—	—	1	—	—	—
64	Emilia sonchifolia (Linn.) DC.	do.	—	—	—	—	—	—	—	1	1
65	Elephantopus spicatus Aubl.	do.	1	—	1	3	6	5	1	—	5
66	Synedrella nodiflora (Linn.) Gaertn.	do.	36	29	34	15	19	9	1	7	5
67	Eclipta alba (Linn.) Rassk.	do.	3	8	6	11	7	6	1	1	1

TABLE 8

Showing abundance of the different species of weeds in the three habitats

No.	WEEDS — Scientific name	FAMILY NAME	NUMBER OF SPECIES FOUND IN THE FIELD								
			Caifigin			Upland			Lowland		
			Plot A	Plot B	Plot C	Plot A	Plot B	Plot C	Plot A	Plot B	Plot C
1	Lygodium japonicum (Thunb.) Sw.	Schizaceæ	—	1	1	—	—	—	—	—	—
2	L. flexuosum (Linn.) Sw.	do.	1	—	1	—	—	—	—	—	—
3	Imperata cylindrica var. koenigii (Retz.) Benth.	Gramineæ	15	3	14	—	—	1	—	—	—
4	Saccharum spontaneum subsp. indicum Hack.	do.	13	6	11	1	—	—	—	—	—
5	Andropogon halepensis var. propinquus (Kunth.) Merr.	do.	—	—	1	—	1	—	—	—	—
6	Paspalum vaginatum Sw.	do.	—	1	—	—	—	1	2	1	1
7	P. conjugatum Berg.	do.	3	7	18	4	11	8	1	2	1
8	P. longifolium Roxb.	do.	1	7	4	2	3	7	1	1	2
9	P. scrobiculatum Linn.	do.	1	—	3	—	—	—	—	—	—
10	Isachne miliacea Roth.	do.	—	—	—	—	—	—	1	—	1
11	Panicum crus-galli Linn.	do.	2	2	2	2	—	—	35	43	67
12	P. flavidum Retz.	do.	1	—	—	1	—	—	1	1	1
13	P. reptans Linn.	do.	1	—	—	—	1	—	1	1	1
14	P. carinatum Presl.	do.	—	—	2	—	1	2	—	—	—
15	P. nodosum Kunth.	do.	1	4	6	—	4	3	1	1	—
16	P. stagninum Retz.	do.	—	—	—	—	—	—	—	2	1
17	Setaria geniculata (Lam.) Beauv.	do.	2	—	1	—	—	1	—	—	—
18	Cynodon dactylon (Linn.) Pers.	do.	1	2	3	—	—	2	—	—	—
19	Eleusine indica (Linn.) Gaertn.	do.	3	—	—	—	1	1	1	2	1
20	Kyllinga monocephala Rottb.	Cyperaceæ	4	9	17	8	8	9	1	2	1
21	K. brevifolia Rottb.	do.	—	—	—	—	—	—	—	1	—
22	Cyperus uncinatus Poir.	do.	—	1	1	—	2	—	1	1	—
23	C. compressus Linn.	do.	—	—	7	—	1	4	1	1	—
24	C. iria Linn.	do.	3	—	1	1	1	1	1	2	1
25	C. difformis Linn.	do.	1	5	5	5	6	6	17	33	46
26	Fimbristylis annua All.	do.	1	1	—	—	1	3	2	1	1
27	F. complanata (Retz.) Link.	do.	2	4	2	3	5	3	1	3	9
28	F. miliacea (Linn.) Vahl.	do.	1	1	1	2	3	3	3	3	6
29	Scirpus grossus Linn. f.	do.	—	—	—	—	—	—	1	2	—
30	S. erectus Poir.	do.	—	—	—	—	—	—	—	1	—
31	Bulbostylis barbata (Rottb.) Kunth.	do.	—	3	4	4	2	1	3	3	4
32	Commelina nudiflora Linn.	Commelinaceæ	1	—	2	—	1	1	—	—	—
33	C. benghalensis Linn.	do.	—	—	1	—	1	1	—	—	—
34	Cyanotis cristata (Blume) C. B. Clarke	do.	—	—	1	—	1	1	—	—	—
35	Monochoria vaginalis (Burm f.) Presl.	Pontederiaceæ	—	—	—	—	—	—	11	4	3
36	Celosia argentea Linn.	Amaranthaceæ	1	1	2	1	—	1	2	1	1
37	Alternanthera sessilis (Linn.) R. Br.	do.	—	1	—	—	—	1	—	2	1
38	Amaranthus viridis Linn.	do.	1	1	4	—	3	3	—	—	—
39	A. spinosus Linn.	do.	1	1	4	27	18	12	—	—	—
40	Cyathula prostrata Linn. Bl.	do.	—	1	—	1	—	1	1	1	1
41	Portulaca oleracea Linn	Portulacaceæ	2	—	1	—	2	2	—	—	—
42	Gynandropsis gynandra (Linn.) Merr.	Capparidaceæ	2	7	2	2	2	1	—	—	—
43	Mimosa pudica Linn.	Leguminosæ	19	8	10	—	—	7	1	2	1
44	Cassia tora Linn.	do.	—	—	1	—	2	1	—	—	—
45	C. occidentalis Linn.	do.	—	—	1	—	3	—	—	—	—
46	Aeschynomene indica Linn.	do.	1	—	1	—	—	1	1	—	1
47	Desmodium triflorum (Linn.) DC.	do.	1	—	1	—	1	1	—	—	—
48	D. gangeticum (Linn.) DC.	do.	2	—	—	—	—	2	—	—	—
49	Indigofera hirsuta Linn.	do.	1	1	3	—	3	1	—	—	—
50	I. suffruticosa Mill.	do.	—	—	2	—	—	1	—	—	—
51	Euphorbia hirta Linn.	Euphorbiaceæ	2	—	2	—	1	2	—	—	—
52	Phyllanthus niruri Linn.	do.	2	—	—	—	2	1	—	—	—
53	Corchorus capsularis Linn.	Tiliaceæ	3	2	1	2	2	2	2	4	4
54	C. olitorius Linn.	do.	—	1	—	—	1	—	1	2	1
55	Malachra capitata Linn.	Malvaceæ	1	2	2	14	13	8	—	—	—
56	Abutilon indicum (Linn.) Sweet	do.	2	—	—	—	—	—	—	—	—
57	Urena lobata Linn.	do.	1	1	1	11	—	6	2	1	1
58	Kosteletzkya batacensis (Blanco) F.–Vill.	do.	1	—	1	—	—	1	—	—	—
59	Jussiaea linifolia Vahl.	Oenotheraceæ	1	—	1	—	—	1	—	—	—
60	Merremia gemella (Burn. f.) Hallier f.	Convolvulaceæ	1	1	3	—	—	3	—	—	—
61	Hyptis suaveolens Poir.	Labiateæ	—	1	2	—	—	2	—	—	—
62	Leucas aspera (Willd.) Spreng.	do.	3	—	1	—	—	1	—	—	—
63	Ageratum conyzoides Linn.	Compositæ	1	—	2	—	—	1	—	—	—
64	Emilia sonchifolia (Linn.) DC.	do.	—	—	—	—	—	—	—	1	1
65	Elephantopus spicatus Aubl.	do.	1	—	1	3	6	5	1	—	5
66	Synedrella nodiflora (Linn.) Gaertn.	do.	36	29	34	15	19	9	1	7	5
67	Eclipta alba (Linn.) Rassk.	do.	3	8	6	11	7	6	1	1	1

STUDIES ON THE MINERAL REQUIREMENTS OF SWINE: I. THE EFFECT OF COMMON SALT AND CHARCOAL, SODIUM SULFATE, AND CALCIUM PHOSPHATE ON THE GROWTH OF PIGS[1]

PLACIDO L. CAVILLERO

The mineral requirements of swine is a problem the importance of which is not realized by Filipino farmers. Investigations carried on in the more advanced agricultural countries, especially in the United States, show that when minerals are given to pigs favorable results are obtained.

A fairly concise summary of the more important known facts regarding the mineral requirements of swine are given by Flores (1922).

Forster and Lunnin, early students of mineral feeding, demonstrated that animals fed with rations free from ash die sooner than if given no feed at all. Bousingault (1846) investigated the effect of feed on the growth of the skeleton of pigs and found that lack of ash in the diet stunted the growth of bones and of the body as a whole. Heiden found that the addition of 25 grams of calcium phosphate to the daily rations of weak pigs produced an increase in weight, but the same treatment produced no effect on strong animals. Burnett from his studies on the bones of pigs receiving rations containing calcium and phosphorus in varying amounts shows that the composition of bones can be modified, the degree of modification depends upon the mineral contents of the ration given. Hart, McCollum, and Humphrey observed that when calcium or phosphorus was lacking in the feed, the skeleton was the most available source of supply. The same authors state that the addition of phosphorus in the form of calcium phosphate to rations low in phosphorus corrected all the pathological disturbances and led to normal growth and development.

Henry and Morrison (1921) state that animals do not thrive well on rations that are rich in protein, carbohydrates, and fat but deficient in mineral matter. They further state that to maintain the normal growth of hogs, their rations should supply not only sufficient protein but also mineral matter.

Evvard (1921) points out that a good ration, such as corn and tankage, may be made more efficient through proper mineral addition.

The present work is the first of a series of experiments to be conducted at the College of Agriculture under the Animal Husbandry Department, with the object of studying the mineral requirements of pigs.

The experiment reported in this paper covered a period of 160 days, from June 3, 1923, to November 9, 1924.

MATERIALS AND METHODS

The animals

On May 31, 1923, 16 pigs were selected from a herd of 28 weanling high grade Berkshires. These pigs were weighed on three successive days and the average weight was taken as the initial weight. The animals were divided into four uniform lots with four pigs in each lot. In making the division the points considered were size, litter, and external characters. All the pigs were in good condition.

[1] Thesis presented for graduation, 1924, with the degree of Bachelor of Science in Agriculture from the College of Agriculture, No. 210; Experiment Station contribution No. 322. Prepared in the Department of Animal Husbandry under the direction of Mr. Mariano Mondoñedo.

The feeds used

The feeds used were rice bran, copra meal, and shelled corn for concentrates, and calcium phosphate, sodium sulfate, common salt, powdered charcoal, and camote pasture for supplements. Rice bran was bought at ₱1.55 a cavan (26 kilograms) by the College in Cabuyao, a town in Laguna Province. Copra meal was bought from The Manila Oriental Oil Company for ₱35.00 a ton. The corn that was used was Native Yellow Flint; part was College product and part was bought at Calamba at ₱5.00 a cavan (58.5 kilograms). The calcium phosphate, sodium sulfate, and common salt cost ₱4.88; ₱0.66; ₱0.10 a kilogram, respectively. As the commercial calcium phosphate and sodium sulfate were not obtainable, chemically pure drugs were used. The charcoal was prepared by burning corn cobs, and was valued at ₱0.04 a kilogram. Camote (*Ipomœa batatas* L.) lots around the hog pen were used for the pasture.

TABLE 1

Showing feed consumption

LOTS	CONCENTRATE MIXTURE				MINERAL SUPPLEMENT				
	Rice bran	Shelled corn	Copra meal	Total	Common salt	Powdered charcoal	Sodium sulfate	Calcium phosphate	Total
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*
I	260.7	186.2	111.7	558.6	——	——	——	——	——
II	259.7	185.5	111.3	556.5	3.52	3.52	——	——	7.04
III	264.2	188.7	113.2	566.1	2.87	2.87	1.44	——	7.18
IV	270.8	193.4	116.1	580.3	2.90	2.90	——	1.45	7.25

Pasture

Practically all the lots around the hog house planted to camote were used for grazing; no definite lots were set aside for this experiment. Care, however, was taken that the pigs had equal access to the pastures. Whenever they were turned out to a new pasture, they first ate the tubers, then the shoots and then the old leaves. There were common grasses growing on the pastures but so long as there was camote to eat the pigs did not touch them.

EXPERIMENT AND RESULTS

Feeding and management

Proportion of feed. Two different mixtures of feeds were formulated. These were the concentrates and the supplemental mineral mixtures. The concentrate mixture, or basal ration, had the proportion of seven parts rice bran, or 46⅔ per cent; five parts shelled corn, or 33⅓ per cent; and three parts copra meal, or 20 per cent. The nutritive ratio of this mixture is 1:6.47. The supplemental mineral mixtures consisted of the following:

Mineral mixture A, 100 parts powdered charcoal; 100 parts common salt.

Mineral mixture B, 100 parts powdered charcoal; 100 parts common salt; 50 parts sodium sulfate.

Mineral mixture C, 100 parts powdered charcoal; 100 parts common salt; 50 parts calcium phosphate.

Lot I, the control, was given no minerals, only the concentrate mixture.

Lot II was given the basal ration plus mineral mixture A.

Lot III was given the basal ration plus mineral mixture B.

Lot IV was given the basal ration plus mineral mixture C.

In mixing the concentrate and the minerals the proportion used was six parts of the mineral mixture to every 100 parts of the copra meal in the basal ration. According to this proportion the mineral mixture was 1.2 per cent of the concentrate mixture.

Manner of feeding

The experimental feeding began on June 3, 1923. The feeds used for concentrate mixture were weighed separately in the proportion in which they were to be mixed; enough to last the pigs about a week was weighed at one time.

All the lots were hand fed. Feeding was done twice a day, in the morning and in the afternoon.

During the first four weeks of the experiment the pigs were kept in the pens, because the pasture feed was not in proper condition. However, they were supplied daily with camote vines, about two kilograms for each lot. This amount was gradually increased in proportion to the increased consumption of concentrate ration and the pigs' growth until about four kilograms were given in the last part of the experiment. On stormy days the pigs were not allowed to stay on the pasture.

Amount of feed consumed

The amount of feed consumed by each lot is given in table 1. It may be seen in this table that there was little difference in the consumption of the lots. Lot I, the control, and lot II, receiving powdered charcoal and common salt mixture, consumed about the same amount; lot III, receiving powdered charcoal, common salt, and sodium sulfate, consumed a larger amount; lot IV, receiving calcium phosphate in addition to powdered charcoal and common salt, consumed the most. The pigs in lot IV had a good appetite at all times.

Rate of growth

The pigs were weighed weekly during the experiment. The greatest increase in weight recorded for one week was four kilograms.

The results are presented in table 2. This table shows that lot IV made the greatest gain during the experiment. There was no material difference between lots I, II, and III.

The experiment was closed on November 9, 1923. During the last week of the experiment three successive daily weighings were made, the average of which was the weight recorded. The average weight of the pigs in each lot was also determined in the same period; it was found that lot I had an average weight of 35.2 kilograms; lot II, 32.6 kilograms; lot III, 33.05 kilograms; lot IV, 42.57 kilograms.

TABLE 2

Showing the average weekly weights of the pigs in each lot

WEEK	LOT I	LOT II	LOT III	LOT IV
	kgm.	*kgm.*	*kgm.*	*kgm.*
June 3, 1923 Initial Weight.	14.0	14.1	14.1	14.1
1st	14.5	14.6	14.9	15.4
2nd	15.8	15.7	16.1	17.0
3rd	17.5	17.6	17.7	19.2
4th	18.0	18.1	18.2	19.6
5th	18.5	19.7	18.4	20.0
6th	18.9	19.9	19.5	21.8
7th	19.4	20.0	20.5	23.2
8th	21.2	20.0	22.8	23.7
9th	20.2	21.8	22.5	25.2
10th	21.1	22.6	23.5	27.2
11th	22.2	23.5	24.7	29.0
12th	23.7	24.6	26.7	31.0
13th	24.8	25.2	26.8	31.5
14th	24.5	25.7	27.4	31.7
15th	26.4	27.0	27.8	32.6
16th	28.0	27.9	28.3	34.8
17th	28.6	27.9	28.2	34.8
18th	30.1	28.9	28.6	35.9
19th	30.9	29.2	29.2	36.2
20th	32.6	30.5	30.5	37.9
21st	33.2	31.2	31.1	39.9
22nd	34.3	31.9	32.4	40.8
23rd	35.2	32.6	32.0	42.5

General observations

The pigs fed with mineral mixtures showed a greater appetite and were more active feeders than those in the control lot.

Fecal examination was made about the middle of the experiment and according to the report of the findings from the College of Veterinary Science all the pigs in lot III were negative for parasites (*Ascaris* and *Oesophagostoma*) but the other lots were infested. The control lot was heavily infested, comparatively.

The first report follows:

Lot	*Pig number*	*Parasites (infestation)*
I	304	*Ascaris*, moderate infestation
	310	*Oesophagostoma*, light
	313	*Oesophagostoma*, light
	317	*Ascaris*, heavy
II	301	Negative
	311	Negative
	344	Negative
	320	*Ascaris*, moderate
III		All negative
IV	302	Negative
	312	*Oesophagostoma*, moderate
	319	*Oesophagostoma*, light
	343	*Oesophagostoma*, light

Another examination towards the end of the experiment showed that the pigs in lot III were slightly infested with *Oesophagostoma*, while the rest remained as at the first report.

During the last week of the experiment the pigs were carefully examined, particularly for general appearance, conformation, condition, and constitutional vigor. It was observed that all the pigs in lot I were laying on fat. They appeared to be well rounded, lower set, and were less bony than those in the lots fed with minerals. They were somewhat sluggish in their movements. The backs were slightly sagging. The pigs in all the mineral-fed lots were practically the same in conformation; that is, they appeared more rangy, loosely coupled, and with less tendency to put on fat than lot I. They looked spare, yet were heavier than the control lot.

DISCUSSION OF RESULTS

It may be seen in table 2 that lot IV gave the best results throughout the experiment, showing that mineral mixture C, consisting of 100 parts powdered charcoal, 100 parts common salt, and 50 parts calcium phosphate, was the best mineral mixture of the three used.

Henry and Morrison (1921) state that over 90 per cent of the mineral matter in the skeleton consists of calcium and phosphorus. Hence, it may be inferred that the favorable results obtained in lot IV may be attributed to the addition of the mineral mixture C, presumably to the calcium phosphate contained in the mixture.

Lots II and III, mineral-fed, showed slightly better results than the control,—lot II up to the 15th week and lot III up to the 16th. After this period the control lot showed the more favorable result up to the close of the experiment reversing the results in the first part of the study. This reversal was probably due to two pigs in lot II and two in lot III being in œstrum during the latter part of the experiment. Without this disturbance the results might have remained in favor of lots II and III, as the four pigs unaffected in these two lots kept up their normal rate of growth.

In the total amount of feed consumed, lot IV, with 587.6 kilograms, was highest; lot III, with 573.3 kilograms was second; lot II, with 563.6 kilograms, was third; and the control lot, with 558.7 kilograms, was lowest. This result agrees with the experimental results obtained by Flores (1922). Commenting on this point he says, "The pigs in the mineral-fed lots consumed a larger amount of feed than the highest check lot, an evidence that showed that minerals had a tendency to increase the appetite of the animals."

The cost of feeds per pig may be seen in table 3. The control lot consumed feed to the value of ₱8.82; lot II, ₱8.93; lot III, ₱9.30; and lot IV, ₱11.06. In average profit per pig, lot IV, in spite of heavy consumption of feeds and of the high cost of the calcium phosphate, with ₱5.97, stands first; lot I, with ₱3.92, second; lot II, with ₱2.47, third; and lot III, with ₱2.13, lowest. Calculation was also made as to the cost of feed per kilogram gain The figures obtained

show that for lot IV, the cost to produce a kilogram gain was ₱0.39; for lot I, ₱0.41; for lot II, ₱0.47; and for lot III, ₱0.49.

TABLE 3

Summary of results[a]

	LOT I	LOT II	LOT III	LOT IV
No. of pigs	4	4	4	4
Average initial age of the pigs (days)	123	159	148	159
Initial weight (kgm.)	56.1	56.4	56	56.6
Final weight (kgm.)	141	132.4	132.2	170.3
Gain (kgm.)	84.9	76	76.2	113.7
Average daily gain per pig (kgm.)	.13	.12	.12	.18
Concentrate mixture consumed (kgm.)	558.66	556.52	556.17	580.31
Mineral mixture consumed (kgm.)	10.00	7.04	7.18	7.26
Total feed consumed (kgm.)	558.66	563.56	573.35	587.57
Average daily consumption per pig (kgm.)	.87	.88	.88	.91
Amount of feed consumed for every kgm. gain	6.58	7.32	7.52	5.17
Amount of concentrate feed per kgm. gain	6.58	7.19	7.16	5.10
Cost of feed per kgm. gain	₱ 0.41	₱ 0.47	₱ 0.49	₱ 0.39
Total cost of feeds consumed	₱35.26	₱35.72	₱37.19	₱44.33
Value of gain at ₱0.60 a kgm. live weight	₱50.94	₱45.60	₱45.72	₱68.22
Cost of feeds per pig	₱ 8.82	₱ 8.93	₱ 9.30	₱11.06
Average profit per pig	₱ 3.92	₱ 2.47	₱ 2.13	₱ 5.97

[a] Experiment covered 160 days.

SUMMARY

1. Among the mineral-fed lots, lot IV, given a supplemental mineral mixture consisting of 100 parts powdered charcoal, 100 parts common salt, and 50 parts calcium phosphate gave the most favorable results. This lot made greater gain than the check lot.

2. There was no material difference between the results of lots I, II, and III.

3. Compared with the control, lot II fed with mineral mixture A showed favorable results from the beginning of the experiment up to the 16th week; lot III fed with mineral mixture B, up to the 17th week. From these dates to the close of the experiment, these two lots, owing to the inability of four pigs to keep up their normal growth on account of certain disturbances, gave unfavorable results, compared with the control.

4. The pigs in the control lot showed a tendency to fatten earlier than the pigs in the mineral-fed lots.

5. The pigs in the mineral-fed lots appeared to be more bony, more active, with longer and coarser hair, and with longer frame of body than the pigs in the control lot.

6. In general, mineral-fed lots were more lightly infested with parasites. Lot III fed with sodium sulfate showed the least infestation.

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EXCHANGE NOTES

Genetics has made possible better strains of livestock. Meat production is more rapid. Food utilization is more efficient. Disease is less to be feared because of resistant stocks. Milk yields are increasing steadily. Both sheep and goats produce longer and stronger wool, or finer and more glossy wool, according to the heritage allotted them.

Among plants there is the same story. New types specialized for different purposes are constantly being created. Novel varieties appear in increasing numbers year by year, and though the great majority of them are probably little better than the older types they are designed to replace, here and there a strain stands out whose inherent merits make it worth millions. In fact, if one studies the chief varieties of farm crops now grown, he finds scarcely a single one which was known to the world fifty years ago, so rapid has been the man-made evolution of the vegetable kingdom.—E. M. East.

Scribner's Magazine, July, 1925.

We are now told that the waste products of the corn crop, such as the cob, stalk, and leaves, are being utilized to make a total of 146 different commodities. The Department of Agriculture tells us that such articles as axle grease, face powder, chair cushions, cigarette holders, gun powder, incense, punk, phonograph records, shaving soap, shoe horns, varnish, absorbent for nitroglycerine in the manufacture of dynamite, and a kind of sugar are made from these waste products of the corn crop. Who would imagine that products differing as widely as axle grease and face powder could come from these waste corn products? Recently while in Louisiana we saw a very large pile of bales of bagasse, which is the pomace of ground-up sugar cane stalks. Until a few years ago this was considered worthless. It is now being utilized for making boards, similar to beaver boards.

Certainly this is a day not only of large production, but also of conservation of every form of waste. May we not make use of this idea on our farms? Literally millions of dollars are wasted on farms every year. Recently we talked with a farmer who said that for a number of years he had been allowing the volunteer onions from his onion field to go to waste, but that for a year or two he had been selling these as green onions and, to his astonishment, found that he had been wasting for years $200 to $250 annually. This is an example of what happens a thousand times over on different kinds of farms throughout the country.

Let's take a leaf from the lesson taught us by these industrial folks and save the waste. The saving of the waste on a farm may very well mean the difference between a profit and a loss.

—*The Progressive Farmer* (Georgia-Alabama, U.S.A.)

Mobilized on the farmers' side are the forces of modern science, and he needs them all. Once in awhile, as in the case of foot-and-mouth disease in this country, he wins a signal victory. But Nature seldom surrenders, and for the most part the farmer must be content if his lines hold, or if his retreat is not turned into a rout. The war on agriculture's many-sided battle line is being fought for the greatest stake in the history of the world—the continued existence of the human race.

—*The Prairie Farmer.*

..... It is well known that local differences in the climate produce a local differentiation in the Flora. As already stated there are three fairly distinct zones, the low lying, the middle, and the upper or mountainous. .....

Besides affecting the distribution, the locality factors markedly influence the structure of the plants themselves. Most of them are xerophytes, because of the scanty rainfall. To conserve the limited supply of water they have gradually reduced their photo-synthetic or assimilating surfaces. Transpiration is lessened by the consequent reduction in the number of stomata, which are more deeply imbedded. The epidermis is thickened. This is perfectly obvious on all sides. The principal indigenous tree plants are coniferous with small acicular leaves. The majority of plants forming the ground Flora have the small leathery leaves typical of xerophytes. In some cases they have been modified to such an extent that the former hard woody stem has become succulent and flaccid, and the leaves have been aborted, their places being taken by small thorns which morphologically indicate their position and former presence. There are of course indigenous broadleaved trees such as the oke and plane which are not xerophytes. These mainly occur as narrow belts along the banks of streams in areas in which there is abundant water. .....

The changes described have taken place gradually since the formation of the Island. Prior to the coming of man, the forests must have covered a great part of the Mesorian Plain, and existed thickly in the mountainous districts. For centuries they have been worked vigorously, and steadily depleted. All that remains is a poor growth covering less than one-fifth of the area of the Island.

On the other hand artificial plantations have been established. Australian plants are thriving most successfully. Seed from plants in India, England, America and other countries is successfully germinating. Their introduction into the Island may in subsequent years be followed by a profuse natural reproduction, so that the character of the vegetation must change considerably. The predominating species will be exotic and will be more closely affiliated to plant societies in the most distant parts of the world.

—*The Cyprus Agricultural Journal* (Nicosia, Cyprus).

There are few people, even among those who spend their lives studying fishes, who always spell correctly the plural of fish.

The rule is that in referring to fish for the table, one should say fish, but in referring to specimens used for scientific study or as living exhibits, *fishes* is correct.—Ida M. Mellen.

—*Zoological Society Bulletin.*

COLLEGE AND ALUMNI NOTES

The Board of Regents and the Executive Committee held sessions in the College Library on September 10. The heads of the departments and divisions of the Associated Colleges at Los Baños entertained the regents and the members of the committee at luncheon. The luncheon was prepared and served under the direction of the Nutrition Division of the Chemistry Department. The major items of the menu were College of Agriculture products. Synthetic jelly, delicious, was a contribution from the "Chemistry Pectin Co." The menu cards, the work of Mr. Villa Luz and C. del Rosario were unique and most attractive. They were lettered with India ink on the inside of halves of bamboo internodes.

Letters from Professor Hester tell of his arrival in the United States in July after a satisfactory trip through Italy, France, and England.

The following interesting letter (a translation) from Mayaguez, Porto Rico, was recently received by Doctor Espino. The letter was written in Tagalog:

"My dear Friend:

I inform you that I have read your articles here at Mayaguez. I am from Pulilan, Bulacan, but was raised in Manila, in Santa Ana district.

(Signed) Gregorio S. Espino."

An inclosed business card tells that Mr. Espino is Designer and Superintendent in the firm of Franklin & Magnus, Inc., Mayaguez, P. R.

The March–April number of *The Journal of the Madras Agricultural Union* quotes in full "Think on these Things in 1925" from THE PHILIPPINE AGRICULTURIST of January.

Two programs were presented on the Campus on August 13, Occupation Day.

In the afternoon the Junior Sugar Technologists presented the following program:

Music—by College Orchestra
Vocal Solo—by Mr. F. Fernandez
Chelin Solo—by Mr. R. Betia, accompanied by Mr. Alvarez
Classic Dancing—by Mr. I. Lim
Violin Solo—by Mr. F. Ortaliz

DRAMATIZATION OF THE KINGDOM OF THE SUGAR TECHNOLOGISTS

King Manalo I (at court) - - Doctor Roxas
Fiji - - - - - - Mr. Grecia
Mosaic - - - - - Mr. G. Guanzon
Pests (locusts, rats, etc.) - - Mr. H. Rosales
Drought - - - - Mr. R. Advincula
Sugar Cane (Badilla) - - Mr. F. Panlilio
H 109 - - - - - Mr. J. Rivera
Negros Purple - - - - Mr. F. Villa
Address—by Doctor M. Roxas
Vocal Solo—by Miss Mamerta Manahan, with Mr. E. Eubanas at the piano
Address—by Dean C. F. Baker

The program was followed by games, refreshments, and as the "shades of evening fell" a huge bonfire was lighted.

In the evening the Student Body presented the following program:

Overture - - - - - - College Orchestra
Significance of the Day - - Lieutenant Martelino
Saxophone Solo - - - - - Mr. M. Valdez
Experiences in the United States - Prof. M. C. Lopez
Vocal Solo - - - - - Mr. F. Fernandez
Athletics in the College - - Dr. B. M. Gonzalez
Experiences in China - - - - Miss M. Wilson
Selection - - - - - - College Orchestra
Award of Athletic Medals and Ribbons - Dean Baker
Chelin Solo - - - - - Mr. R. Zarragoza
Selection - - - - - - College Orchestra
"Philippines, my Philippines" and "America" - Audience

The thirteenth meeting of the Los Baños Biological Club was held in the auditorium of the College of Agriculture in the evening of August 27. An interested audience composed of the faculty members and students of the Associated Colleges took part in the discussions of the papers presented.

Dr. R. B. Espino of the Plant Physiology Department spoke on "Further Studies on the Salt Requirements of Young Rice Plants" giving the results of his experiments on attempts to find the salt mixtures best suited for the growing of the young healthy rice plants. The second paper of the program, "An Outbreak of Fowl Cholera in Los Baños," was read by Dr. A. K. Gomez of the Department of Bacteriology and Pathology, College of Veterinary Science. Doctor Gomez discussed the etiology, symptomalogy, pathology, and prophylaxis of an epizootic disease of chickens, ducks, and turkeys based upon an outbreak which occurred in the poultry yards of the College of Agriculture.

A number of enthusiasts in the faculties of the Associated Colleges at Los Baños have formed a tennis club, the officers of which are: Dr. Nemesio B. Mendiola, President; Dr. Sixto Francisco, Vice-President; Prof. Mariano Lopez,

Secretary-Treasurer; and Dr. Robert Pendleton, Manager. It is proposed to build either a cement or a sand court. Because of the inconvenience of building such a court under private auspices, it is intended to ask the University to build one and sell it to the Club. A committee composed of the President and the Manager was appointed to discuss the matter with Dean Baker and President Palma.

A Junior Agricultural Congress composed of over forty charter members, all of whom are juniors, seniors or graduate assistants in the College of Agriculture has been organized and will hold regular meetings on the third Wednesday evening of each month.

The main purpose of the organization is to give to its members actual training in parliamentary proceedings, platform work in presenting papers and reports. The secondary purpose is to secure prominent men outside the College who are engaged in some phase of agriculture to talk before the congress on topics and problems relating to agriculture in the Islands.

The Officers of the Congress are:

Salustiano Gonzales, President
E. R. Mendiola, Vice-President
D. Suerte, Secretary
M. Kalaw, Reporter

Prof. T. F. O'Leary is Faculty Adviser of the Organization.

Mr. Eligio J. Tavanlar, B. Agr. '25, now a cadet in United States Military Academy, West Point, writes Mr. Hernandez, Librarian, College Library: "I am as much interested in my Alma Mater as in the Military Academy. I consider myself still an integral part of the College Student Body. . . ."

As evidence that his letter is not "words, idle words," Mr. Tavanlar sent by same mail copy of "Bugle Notes" for the Library and states in his letter that he has subscribed for the Academy paper, *The Pointer*, a bi-monthly publication for the Library.

Mr. Melecio Manio, B. Agr. '19, now teaching biology in Nueva Ecija High School, San Isidro, in a letter to Doctor Espino expresses regret for an advanced credit received in college. He says: "I think I missed a whole lot by not taking Botany I in college. I did take Botany II, III, and IV, but the fundamentals I escaped as I was given credit for the Botany I I had taken in high school."

New books and other publications added to the Library of the College of Agriculture, July–August, 1925.

Arnold, J. L.
Concise technical physics. 1916.

Bassel, B.
Earth dams. 1907.

Brate, H. R.
Farm gas engines. 1912.

The Breeder's Gazette (Compiler)
Farm buildings.

Bugle notes. 1925.

Campbell, H. C.
Concrete on the farm and in the shop. 1920.

Cobleigh, R.
Handy farm devices and how to make them. 1913.

Clow, G. B.
Practical up-to-date plumbing. 1923.

Croft, T.
Wiring for light and power. 1924.

Daugherty, R. L.
Hydraulics. 1925.

Ellis, E. T.
Black's gardening dictionary. 1921.

Fiske, G. B.
Poultry architecture. 1919.

Good Printing, vol. 1 and 2.

Good, F. F.
Automobile laboratory manual. 1922.

Harris–Allen (eds.)
Webster's new international dictionary of the English language.

Hogle, Wm. H.
Internal combustion engines. 1909.

Ibañez, V. B.
The four horsemen of the Apocalypse. 1924.

Karapetoff, V.
The electric circuit, 1st and 3rd editions. 1912.

Keene, E. S.
Mechanics of the household. 1918.

Kirkwood, E. J. G.
Plants and flower forms. 1923.

Koester, F.
Electricity for the farm and the home. 1913.

Lowell, W. H.
The plane table and its use in surveying. 1908.

Lytton, E. B.
The last days of Pompeii.

Malcolm, C. W.
A text book on graphic statics. 1922.

Malcolm, G. A. et al.
Philippine government. 1923.

Mason, W. P.
Water supply. 1918.

Mead, D. W.
Hydrology, the fundamental basis of hydraulic engineering. 1919.

Ogday, H. N.
Rural hygiene. 1920.

Oudemans, C. A. J. A.
Enumeratio systematic fungorum. Vol. 5. 1924.

Page, V. W.
Automobile repairing made easy. 1924.

Page, V. W.
The modern gas tractor construction, utility, operation and repair. 1924.

Parsons, J. L.
Land drainage. 1915.

Philip, J. C.
Physical chemistry. 1925.

Poole, C. P.
Diagrams of electrical connections. 1907.

Poorman, A. P.
Applied mechanics. 1923.

Popular mechanic shop notes. Vols. 11–21. 1915–1925.

Powers, W. L.
Land drainage. 1924.

Putnam, W. P.
The gasoline engine on the farm. 1919.

Robb, B. B. et al.
Farm engineering. 1924.

Santee, E. M.
Farm sewage. 1918.

Schneider, N. H.
Low voltage electric lighting with storage battery. 1916.

Shearer, H. A.
Farm mechanics, machinery and its use to save hand labor on the farm. 1918.

Small, Ll. L.
Elements of the theory of infinite processes. 1923.

Slocum, S. E.
Elements of hydraulics. 1917.

Smith, L. R.
Industrial physics—(heat). 1924.

Smith, L. R.
Industrial physics—(mechanics). 1922.

Smith, R. H.
Agricultural mechanics. 1925.

Society of Chemical Industry.
Reports of the progress of applied chemistry, vol. 8, 1923.

Steinmetz, C. P.
Engineering mathematics. 1917.

Stephenson, H. J.
Farm engines and how to run them. 1923.

Stories from the Arabian nights. 1897.

Summer, S. C.
Supervised study in mathematics and science. 1922.

Tervooren, H. A. P. M.
Handboek ten dienste van de suikerriet en de rietsuiker—fabricage of Java. 1919.

Washington, Booker T.
Up from slavery. 1901.

Whitman, W. G.
Household physics. 1924.

Wyner, S. S.
A treatise on producer gas and gas producer. 1906.

Widtsoe, J. A.
Dry farming. 1921.